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ABSTRACT

Recognition errors of children in Grades 2, 4, and 6 were examined. Subjects learned words under intentional or incidental instructions and were tested immediately or 48 hours later. Subjects had to choose a target word from among acoustic, conceptual, associative and neutral distractors. The immediate recognition of 2nd-grade subjects was dominated by acoustic errors, that of 4th and 6th graders by associative and conceptual errors. Instructions had little effect on types of errors. Over the interval, acoustic errors decreased relative to the other error types. Development changes in memory attributes and differential forgetting of attributes was inferred. (Author)

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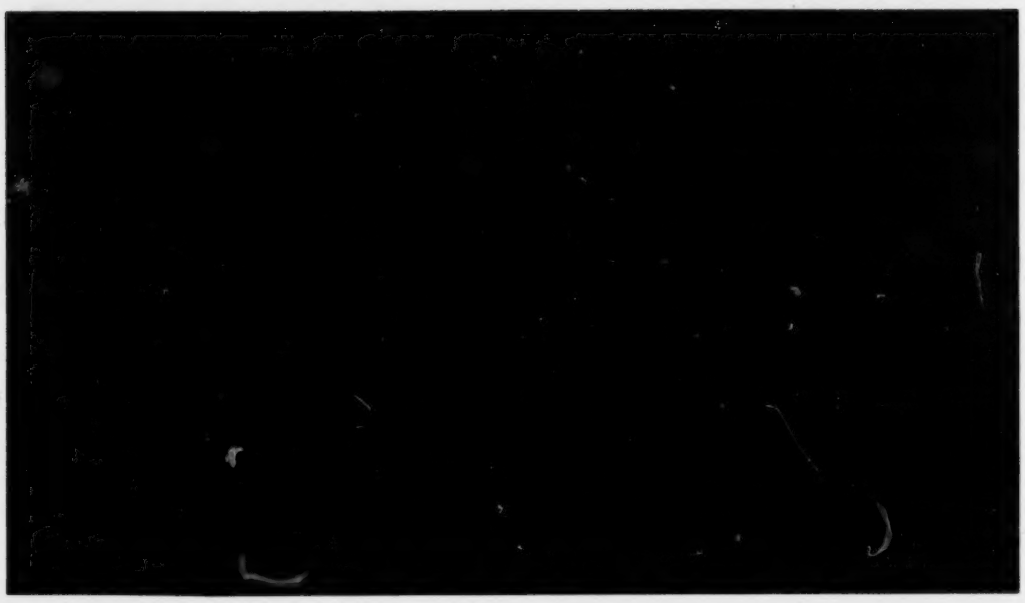

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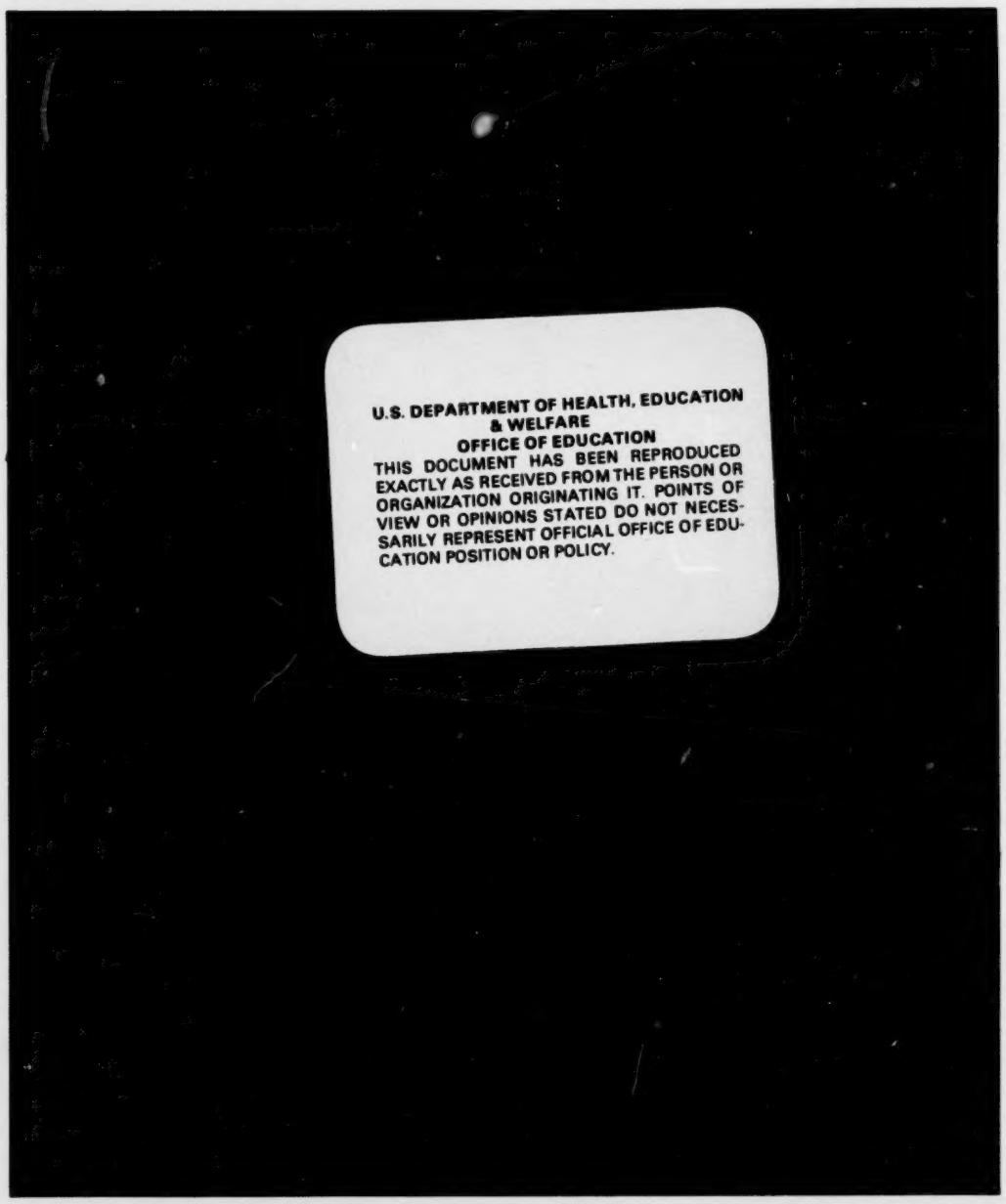
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ENCODING VERBAL UNITS IN MEMORY: CHANGES IN MEMORY ATTRIBUTES AS A FUNCTION OF AGE, INSTRUCTIONS, AND RETENTION INTERVAL

Report from the Project on Situational Variables and Efficiency of Concept Learning

By Elizabeth Schwenn Ghatala

Herbert J. Klausmeier, Professor of Educational Psychology
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Wisconsin Research and Development
Center for Cognitive Learning
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Madison, Wisconsin

June 1970

This Technical Report is a doctoral dissertation reporting research supported by the Wisconsin Research and Development Center for Cognitive Learning. Since it has been approved by a University Examining Committee, it has not been reviewed by the Center. It is published by the Center as a record of some of the Center's activities and as a service to the student. The bound original is in The University of Wisconsin Memorial Library.

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The Wisconsin Research and Development Center for Cognitive Learning focuses on contributing to a better understanding of cognitive learning by children and youth and to the improvement of related educational practices. The strategy for research and development is comprehensive. It includes basic research to generate new knowledge about the conditions and processes of learning and about the processes of instruction, and the subsequent development of research-based instructional materials, many of which are designed for use by teachers and others for use by students. These materials are tested and refined in school settings. Throughout these operations behavioral scientists, curriculum experts, academic scholars, and school people interact, insuring that the results of Center activities are based soundly on knowledge of subject matter and cognitive learning and that they are applied to the improvement of educational practice.

This Technical Report is from the Situational Variables and Efficiency of Concept Learning Project in Program 1. General objectives of the Program are to generate new knowledge about concept learning and cognitive skills, to synthesize existing knowledge, and to develop educational materials suggested by the prior activities. Contributing to these Program objectives, the Concept Learning Project has the following five objectives: to identify the conditions that facilitate concept learning in the school setting and to describe their management, to develop and validate a scheme for evaluating the student's level of concept understanding, to develop and validate a model of cognitive processes in concept learning, to generate knowledge concerning the semantic components of concept learning, and to identify conditions associated with motivation for school learning and to describe their management.

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The early days of marital adjustment can be hectic; when both husband and wife are completing their dissertations they can be virtually overwhelming. I thank my husband, Habeeb, for remaining calm, cool, collected and loving throughout this difficult period.

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Chapter I

INTRODUCTION

Memory can be conceptualized as consisting of a collection of attributes which serve to discriminate one memory from another and to act as retrieval mechanisms for a target memory. In this context, encoding an item for the memory system represents the process by which the attributes of a memory are established. The conceptualization of memory as a collection of attributes or features has been advanced in recent papers by Underwood (1969) and Wickens (1970). An earlier paper by Bower (1967) expresses much the same view.

The memory unit which has concerned most previous investigators and which is the unit of concern in the present study is the verbal unit. Although it can be argued that the conceptualization of a memory in terms of its attributes applies to memory for all types of events, for purposes of analysis it is convenient to restrict the size and type of event to be remembered to the verbal unit.

Various types of attributes, which can be thought of as dimensions or categories into which units can be encoded, have been identified. For example, Underwood (1969) discusses some eleven characteristics of verbal materials which may serve as either discriminative or retrieval attributes in memory. However, he makes no claim that his

analysis is an exhaustive one. Some of the characteristics described by Underwood are intrinsic to the units themselves such as their orthographic characteristics; other characteristics derive from the tasks in which verbal units may be presented for learning. For example, the position of units along a temporal-spatial dimension may become an attribute when the units are to be learned in a sequence as in a serial-learning task. Presumably the attributes which are established, then, depend upon the nature of the verbal units themselves and the characteristics of the task in which they are presented. In addition other factors may influence the way in which units are encoded.

Subjects may differ in the ways in which they encode the same material. One subject variable related to encoding which has received some study and which was investigated in the present study is that of chronological age (Bach & Underwood, 1970; Felzen & Anisfeld, 1970). In the present study the general hypothesis was that some ways of encoding are more primitive than others, and that as an individual matures and gains more experience in the verbal domain, "higher level" attributes begin to predominate in his memory for verbal materials. Specifically, the more primitive levels of encoding are thought to involve the physical or perceptual aspects of the stimulus word such as its acoustic or orthographic properties. Higher levels of encoding involve the semantic properties of words, that is, either the denotative or connotative meanings of words.

The specific attributes studied in the present experiment were the acoustic, the conceptual and the associative attributes. Briefly, the acoustic attribute consists of the sound of a word or series of letters when pronounced either aloud or covertly. The conceptual attribute consists of tagging the word as referring to a member of a concept or class. The tag may consist of the concept or class name. For example the word dog may be tagged as a member of the class animal. The associative attribute consists of the verbal associates which a word elicits from a S. The associative attributes are usually iden- as the most frequent responses to a word in word-association procedures. The mechanism by which the conceptual and associative attributes occur may well be the same. That is, an associative process may underlie both types of attributes. The distinction made here between conceptual and associative encoding is based on the type of response elicited by the verbal unit. Thus, the conceptual attribute might be considered a special case of the associative attribute.

The developmental hypothesis with respect to these attributes is that the acoustic attribute represents a more primitive level of encoding and should thus be utilized more by young children. With older children encoding along semantic dimensions should predominate. Thus, the conceptual and associative attributes should come to dominate the acoustic attribute with increasing age. Moreover, to the extent that conceptual responses to words can be said to represent a higher level of encoding than associative responses, the conceptual attribute should come to dominate the associative attribute with increasing age.

The attributes which develop during learning may also depend upon the instructions under which learning occurs. Postman (1964) has maintained that the difference between learning under intentional and incidental conditions is the occurrence of associative attributes, these being more common under intentional instructions. If one views the conceptual attribute as occurring by the same associative mechanism as do associative attributes, then a greater number of conceptual responses would be expected under intentional instructions than under incidental instructions. In the present experiment Ss were presented with materials under either incidental or intentional learning conditions with the expectation that associative and conceptual encoding would occur less often in the incidental condition as compared to the intentional learning condition.

Previous studies (Back & Underwood, 1970; Anisfeld, 1969) have suggested that attributes may be forgotten at different rates. Specifically, these studies showed the acoustic attribute to be forgotten more rapidly than the associative attribute. Thus, in addition to exploring the effects of age and instructions on the attributes developed during learning, the present study also investigated the retention of attributes over time.

Method

The experiment was designed to investigate developmental changes in memory attributes developed during learning. The attributes investigated were the acoustic, associative and conceptual attributes. Further, the study explored the influence of type of instructions

under which a task is presented and the development of memory attributes. Finally, the retention of the above attributes was compared.

Subjects were second-, fourth-, and sixth-grade children. Eighty children were run at each grade level for a total sample of 240 Ss. The sexes were equally represented at each grade level. Within levels of grade and sex, the Ss were randomly divided into four groups representing the factorial combination of instructional condition (intentional or incidental) and retention interval (immediate or 48-hour retention).

All Ss received the same recognition-learning task which involved the following procedure. A series of 45 words were presented one at a time at a 3-second rate. The words were presented visually and at the same time pronounced by E. After a single presentation of all the words, Ss were given a forced-choice recognition test for 25 of the original 45 words. On each test item the Ss were presented with the correct word along with four distractors words. One of the distractors was an associate of the correct response, another was conceptually related to the correct response, a third word was acoustically similar to the correct response and the fourth distractor was a neutral word, unrelated to the correct response. The Ss were told to select the correct word. The assumption was that the memory attributes developed during learning would be reflected in the relative frequencies of the four types of errors.

Subjects in both the incidental and intentional groups were told that the purpose of the experiment was to determine how children in their grade pronounce certain words. The children in the intentional

group were further instructed to try to learn the words because they would be given a test in which they would have to pick out the words they had been shown from among words that they had not been shown.

Subjects in the immediate retention condition received their first recognition test item within two minutes after presentation of the last words. Subjects in the delayed retention group were tested 48 hours later.

Multivariate analyses of variance were carried out on linear combinations of the error scores in order to determine the effects of grade, instructions and retention interval.

Significance of the Study

The focus of the study was on gaining knowledge about the changes in memory attributes which occur with age and with increased school experience since the two are highly correlated in this culture. Since a great deal of what is learned at all age levels is learned under incidental learning conditions, it seemed important to investigate the development of memory attributes under such conditions. Finally, if memories for events are conceptualized as collections of attributes, then, in order to understand the process of forgetting, the loss of memory attributes of different types over time must be studied.

Chapter II

REVIEW OF RELATED LITERATURE

The purpose of the first section of this chapter is to provide an overview of research and theory in the area of memory which supports the conceptualization of memory as a collection of attributes. Further, the types of attributes which have thus far been identified as playing a role in the memory for single verbal units are discussed. In the second section, the three attributes investigated in the present study are examined in more detail. In section three the literature related to developmental changes in memory attributes is discussed. Section four deals with the literature related to encoding processes and instructional conditions. In section five the long-term retention of attributes is discussed.

Analysis of Memory into Attributes

Two lines of current research are relevant to the identification of memory attributes. One is the work by Wickens (1970) on stimulus encoding and short-term memory (STM) and the other is a theoretical development by Underwood (1969) of the concept of memory attributes.

Wickens' work is concerned with proactive inhibition (PI) in STM. The basic notion is that a word when perceived by a S is encoded into various categories which taken together constitute the meaning of

that word. For example, the word horse may be simultaneously encoded into a conceptual category--animal and a syntactic category--noun. The word as presented may be tagged acoustically as consisting of certain sounds; it may be tagged by presentation modality (auditory or visual) and so on. The way that Wickens has studied this type of encoding is by looking at interference effects in STM. The basic procedure followed that of Peterson and Peterson (1959) with a slight twist.

Using the Peterson and Peterson technique, Wickens presented an item for recall after a 20-second interval. A series of such presentations and recalls were given, utilizing items which could be encoded in the same fashion. For example, the items may be names of countries (England, France, Italy) or items which are acoustically similar. The curve showing recall for successive items was usually a monotonically decreasing one, indicating the build-up of PI. The experimental group was then given a fourth item for recall which did not fall into the same class as the preceding items. A control group got another item in the same class. In general, recall of the fourth (switch) item for the experimental group was higher than recall of the fourth (nonswitch) item in the control group. Wickens concluded from this release-of-PI effect that Ss had switched encoding categories. Wickens has found the same type of result (build-up of PI and then release after switch) for various kinds of materials.

The magnitude of the release-from-PI effect varied depending upon the materials used. In general, larger effects were found with changes in semantic content, whereas changes in the physical characteristics

of words produced a lesser effect. Some of the semantic characteristics of words which appeared to be utilized as encoding categories were: taxonomic class, connotative meaning (as measured by the semantic differential), sense impressions and frequency. The shift effects for the grammatical class of words were not of appreciable magnitude. Some of the physical characteristics of words which produced significant shift effects were: acoustic-articulary properties, number of syllables, and number of phonemes. A shift in presentation modality (visual to auditory) also resulted in substantial release from PI.

Wickens concludes from his research in STM that Ss do have rather stable ways of encoding stimulus items presented for recall. His tentative interpretation of the shift phenomenon is that the altered materials, because they are encoded differently from the preceding materials, supply a new, and for one trial, a unique retrieval cue. Therefore, interference between the last item and the preceding items at the time of recall is reduced.

While Wickens has noted the implications of his work on encoding categories for the memory process, he has emphasized more the implications of his research for word perception. That is, he considers his research on encoding categories as an empirical approach to word perception and meaning. On the other hand, Underwood's (1969) work on attributes of memory really constitutes a theory of memory. According to Underwood,

> . . . memory for an event per se has no psychological meaning because a memory without attributes is incapable of being remembered (retrieved). There is no "corpus" which can be recalled directly. Furthermore, differences in the attributes for different memories are fundamental

> for discriminating or differentiating memories, hence are fundamental for understanding the failure of S to perform perfectly on a retention test, i.e., for understanding forgetting (p. 559).

Underwood has identified a number of attributes which may be involved in the memory for words. The evidence for these memory attributes was derived mainly from his own and others' work in the verbal-learning laboratory.

Underwood's basic notion is that as a S learns material he is establishing attributes which serve as the long-term memory for the material. Presumably, the attributes which are established depend on the material to be remembered, the nature of the task in which the material is presented, and the conditions under which the material is presented. Some of the attributes identified by Underwood are discussed briefly below.

The memory of an event may carry a temporal attribute since the perception of an event occurs at a given point in time. Underwood cited Yntema and Trask (1963) as having shown that Ss can make a reliable temporal discriminations for items presented early and late in a series. Yntema and Trask concluded that a memory carries a time tag. Other evidence (Underwood & Freund, 1968a) suggests that temporal discrimination may drastically reduce the interference between two lists.

When one cannot recall a particular fact about which one has read, it is not unusual that one can recall the position of that fact on a page in a book. That is, a memory may carry a spatial attribute

Serial learning may well involve the learning of a spatial attribute for successive words in a list.

Evidence for a frequency attribute which is independent of associative strength was also presented by Underwood. Subjects can judge quite accurately the frequency with which different events have occurred. These judgments are mediated by a frequency attribute which exists as a component of the memory for such events.

Material may be presented for learning by auditory signals or by visual signals. The question is whether a memory can carry a modality attribute which distriminates it from a memory carrying an attribute signifying a different modality. There is evidence that retroactive inhibition (RI) is reduced if the original and interpolated lists are presented by different modalities (Inoue, 1968). Wickens (1970) has shown release from PI after switching modalities in STM experiments.

The work by Brown and McNeil (1966) on the "tip of the tongue" phenomenon was cited by Underwood to indicate that memory for a word may include an orthographic attribute. Essentially this phenomenon consists of Ss being able to correctly characterize words which they cannot recall as to the number of syllables and the initial letter. A recent study by Zechmeister (1969) shows that Ss can reliably scale printed words on their orthographic distinctiveness. Experiments using Zechmeister's materials could be carried out to determine if this type of orthographic property could serve as a discriminative cue in memory.

The memory for a letter, syllable, word, or series of words may carry an acoustic attribute. One could argue that this attribute, at least in hearing Ss, is always present. As Underwood pointed out, however, the question is whether the acoustic attribute plays a discriminative role in memory. Work in STM (Conrad, 1964) shows the acoustic attribute to play a dominant role with low-meaningful material. That is, interference in STM with low-meaningful material is predominately acoustic interference. With material of high meaningfulness, other, more dominant, attributes may limit the role of the acoustic attribute.

Another attribute which functions to discriminate memories within a modality is the visual attribute which consists of images. Subjects may encode words to be learned by representing each with an image of the object symbolized by the word. There is evidence that images may be present during learning (Pavio, 1967; Pavio & Madigan, 1968) and thus become attributes.

Words may be associated with certain nonverbal affective responses. A memory, therefore, may consist in part of an affective attribute. When an affective attribute is defined by dimensions of the semantic differential, effects on memory are demonstrable (Wickens, 1970).

When a word is presented, it may elicit implicit verbal responses which then become an attribute of the memory for that word. For a specific word in a task the attribute can be identified as the overt response produced in word-association procedures. Thus, the associative attribute might consist of an antonym or a synonym. A word might also elicit a superordinate term or concept name which then becomes part of the memory for the word. This can be called a conceptual attribute.

The above are some of the attributes identified by Underwood by which Ss may encode verbal units. They are the cues which are used for later retrieval and discrimination of the memories for these units.

Other authors, most notably Bower (1967), have discussed the notion of the organization of memory in terms of multiple components of the memory trace. More recently, Bower (1970) has discussed the relationship between the organizational properties of material and the encoding and retrieval strategies employed by Ss. Many of the higher-order retrieval schemes discussed by Bower involve the conscious application of rules and strategies during learning and recall. Since this work goes far beyond the discussion of the memory attributes for single words, it will not be discussed further except to say that the use of higher-order retrieval schemes appears to begin with and depend upon the fact that Ss rather automatically encode single words in terms of their semantic and physical features.

The Acoustic, Associative and Conceptual Attributes

The present experiment was analytical with regard to three types of memory attributes, the acoustic, the associative and the conceptual. This section explores the evidence related to the role of each of these attributes in memory.

The acoustic attribute consists of the sounds produced when a verbal unit is pronounced, and it would seem that in hearing Ss the acoustic attribute is an inevitable part of the memory for verbal

material. The question explored here is whether or not the acoustic attribute plays a role in the discrimination of different memories. Work in STM (Conrad, 1964; Wickelgren, 1965), shows a positive relationship between acoustic similarity and errors in recall of letters and digits. However, numerous studies have shown that with meaningful materials the acoustic attribute plays a lesser role in the memory of adult Ss.

Using a forced-choice recognition procedure in which one distractor on the test was associatively related to the correct word, another was acoustically related to the correct word, and a third distractor was unrelated to the correct word, Underwood and Freund (1968b) found that college students made no more acoustic errors than neutral errors. In a study by Davis (1967) a false-recognition procedure in a continuous-recognition task for words was utilized. In this task some 200 or more words are read one at a time. For each word the S makes a judgment as to whether or not the word has been read to him earlier in the list. By including words which are similar in various ways to words which actually occurred earlier in the list and measuring the number of false-recognition responses to these similar items, it is possible to make inferences concerning how Ss encoded the original items. Davis found that while semantic relationships between words produced a high false-positive error rate, there was little evidence that homophonic relationships between words has such an effect.

Marshall, Rouse and Tarpy (1969) also used the false-recognition procedure with college students. They found that words which were semantically related to preceding words resulted in higher false-positive rates than did words which were acoustically similar to previous words. There was no control condition reported in the experiment so it is impossible to determine if the error rate for acoustically similar items exceeded chance. However, the study does show semantic encoding to play a larger role than acoustic encoding. Finally, Wickens and Ecker (1968) found that with adult Ss semantic factors override acoustic factors in STM.

On the other hand, there is some evidence that the acoustic attribute plays a role in memory for words in both short-and long-term memory. Anisfeld (1969) using a false-recognition procedure with college students found that words related either semantically or phonetically to previously heard words produced more false-recognition errors than control words, suggesting that phonetic traces, not only semantic ones, play a role in the memory for words.

Wickens (1970) reported an experiment by Graf (1968) in which acoustic similarity was manipulated in a paired-associate transfer design. Four transfer paradigms were used in the experiment. One group of college students received an A-B, A-B' paradigm in which the stimuli in the two lists were the same two-digit numbers, and the responses paired with the same stimulus term in each list were acoustically similar (e.g. sneeze-tease). A second group received an A-B, A-B'_r paradigm in which the materials were the same as those

used in the A-B, A-B' condition except that acoustically similar responses in the first and second lists were never paired with the same stimulus term. In addition there was an A-B, A-C group for which the stimuli in the two lists were the same but the responses were completely dissimilar. Finally, a group receiving an A-B, C-D paradigm was run as a control. The results showed that while the A-B, A-B' paradigm, normally a positive transfer paradigm, did not differ from the control, the A-B, A-B'_r paradigm produced significant negative transfer which was greater than that produced by the A-B, A-C. Wickens points to the performance of the A-B'_r group as clearly indicating acoustic encoding in long-term memory.

In conclusion, the evidence on the role of the acoustic attribute in memory is rather mixed. It seems clear that with low-meaningful material, acoustic encoding is prominent. With high-meaningful material, at least with adult Ss, it appears that encoding along semantic dimensions predominates with the acoustic attribute playing a lesser role. However, as some studies have shown, even with adults, the acoustic attribute may still play a role in both short- and long-term memory for words.

Both the associative and conceptual attributes, as opposed to the acoustic attribute, involve semantic features of words. A specific associative attribute for a word is defined as a word elicited by that stimulus word in free-association procedures. The word elicited by the stimulus word may bear a number of relationships to the stimulus word. It may be an antonym (up-down), a synonym (rug-carpet) or a

word describing the function of the stimulus word (knife-cut). For the purposes of the present experiment no distinction was made between these different kinds of associates. The stimulus word may also denote a member of a class or concept (cat-animal). The class name or concept label may or may not be given as a high frequency response to the stimulus word, however, the stimulus word is a high frequency response to the class name. In the present experiment only class names of this sort defined the conceptual attribute of a word.

There is evidence from numerous sources that associative attributes play a large role in memory for words. Underwood (1965), Davis (1967), Anisfeld and Knapp (1968), and Fillenbaum (1969) all using the false-recognition procedure found significant false-recognition rates for words which were either antonyms, synonyms or simply high associates of preceding words in the list.

One interpretation of this false-recognition phenomenon (Underwood, 1965; 1969), in terms of its underlying mechanism, is that when a word is presented, the S in addition to perceiving the word, makes an implicit verbal response to that word which is stored in memory along with the internal representation of the actually presented word. If a later word in the list is the same as the implicit response made to an earlier word, then the S may match the later word with the implicit response in memory and incorrectly decide that he has been shown the word

before. For example, if, when the word up occurs early in the list, the S makes the implicit response down, then later when the word down actually occurs the S may decide that he has seen the word down previously.

Underwood's interpretation argues that part of the encoding of words involves the implicit elicitation of verbal associates which are then stored as attributes of that word in memory. There is also evidence that superordinate terms or class names may occur as implicit responses and become stored along with a word in memory thus producing false-recognition responses when the class name is actually presented (Underwood, 1965).

Developmental Changes in Memory Attributes

One finding already noted with adults is that with high-meaningful material the attributes dependent upon the semantic features of the material appear to dominate the acoustic attribute which is related to the physical properties of the material. With material of low meaningfulness it is as if adults "fall back on" a more primitive level of encoding. It seems reasonable to suppose that young Ss, in whom implicit verbal responses to words are fewer or weaker than in adults, may rely to a greater extent on more primitive levels of encoding which do not involve such responses. As children mature and concomitantly gain more experience in the language, these types of verbal responses become stronger and begin to dominate the more primitive attributes in the memory for verbal material.

A study by Bach and Underwood (1970) provides direct evidence for this hypothesis. Children in Grades 2 and 6 were presented with a list of 40 words to learn. After the single presentation trial, each word was tested for recognition. On the test the Ss were required to choose the correct word from among three distractors. One distractor was an associate of the target, one was acoustically similar to the target and the third distractor was a neutral word unrelated to the target. At Grade 2 the acoustic errors were more numerous than the associative errors. At Grade 6 the associative errors far outnumbered the acoustic errors. Thus, there was found a significant interaction between grade level and type of errors in recognition. The conclusion was that young children rely more heavily than older children upon acoustic properties of words when encoding for memory. In older children the associative attribute rather completely dominates the acoustic attribute.

Felzen and Anisfeld (1970) studied the effects of semantic and rhyming relations on false recognition in third- and sixth-grade children. They found that both factors generally produced false-recognition effects at both age levels, but that the rhyming factor played a relatively stronger role in the younger children and the semantic factor a relatively stronger role in the older children.

Less direct evidence related to the developmental hypothesis is provided by Luri and Vinogradova (1959). These authors were interested in the objective study of the structure and dynamics of semantic systems. When words were presented to normal children

(11-15 years) there first occurred an orienting reaction (OR) to each word. The OR consisted of digital vasoconstriction and cephalic vasodilation. The OR extinguished after some 15 to 20 words has been presented. When one of the words (Koshka-cat) was given signal value by requiring Ss to press a button when the word was presented, the OR to the word returned and did not extinguish until the motor response had become automatic (20 to 40 trails). The authors then tested for generalization of the OR to words related to the conditioned word. With normal Ss the OR occurred (in the absence of the motor response) to words related in meaning to the conditioned word, whereas neutral words unrelated to the key word and words phonetically similar to the key word did not elicit the OR. Mentally retarded children with slight or moderate disability gave ORs to words related in meaning to the key word and to phonetically similar words. More severely retarded children gave ORs only to words phonetically related to the key word. Words related in meaning to the key word did not elicit ORs from these children.

The thesis that mentally retarded Ss represent an early point along the normal developmental curve should probably not be pressed too hard. However, the Russian data does suggest that phonetic or acoustic encoding does predominate at more primitive levels of intellectual functioning.

In the present experiment, children from Grades 2, 4, and 6 were tested in a recognition task similar to that used by Bach and Underwood (1970). Subjects were required to choose the word they

had seen before from among four distractor words. One distractor was acoustically similar to the correct word. Another distractor was an associate of the correct word. The third distractor was the name of the class or concept of which the correct word was an example. A neutral word unrelated to the correct word constituted the fourth distractor. The expectation was that acoustic errors would be more numerous for the second-grade children and show a decrease for the fourth- and sixth-grade children. The associative and conceptual errors should both increase with grade. No firm prediction concerning differences between associative and conceptual errors as a function of age was made. However, if conceptual errors reflect a "higher level" of encoding than associative errors, then one might expect associative errors to be relatively more numerous than conceptual errors at lower grades and conceptual errors more numerous than associative errors at higher grades. Superordinate responses to stimulus words in word-association procedures do appear to increase with age up to about Grade 6 (Palermo, 1963). However, after Grade 6 superordinate responses decline in relative frequency. Thus, the function relating age and superordination, at least as reflected by word-association procedures is not a simple one.

Memory Attributes and Instructional Condition

When Ss are presented with a list of verbal units and are informed of an impending memory test, their performance generally exceeds the performance of uninstructed Ss (McLaughlin, 1965; Postman, 1964).

One reason for this difference in performance may be a difference in the amount of rehearsal in the two conditions. Mechanic and Mechanic (1967) developed a procedure which resulted in the elimination of the advantage of instructions to learn. In the Mechanic procedure, nonsense syllables were presented at a rapid rate and Ss not instructed to learn were required to pronounce the syllables. This procedure presumably minimizes differences in rehearsal between intentional and incidental learners.

Wallace (1968) has suggested that in addition to priming rehearsal, instructions to learn also prime the occurrence of implicit verbal responses to the material being learned. The implication of Wallace's suggestion is that with meaningful materials, even with procedures which minimize differences in rehearsal, there will be differences in performance between incidental and intentional learners. The direction of the difference depends upon whether the implicit verbal responses produced by intentional learners aid or interfere with performance on the memory test.

To test his hypothesis Wallace (1968) used a false-recognition task in which some experimental words appearing in the second half of the list were associates of preceding critical-stimulus words, and other experimental words were phonetically similar to preceding critical-stimulus words. One group of college students was not instructed to learn the words. Instead these Ss were told that they were participating in a phonetic spelling experiment and that as each word was read they were to write down a single letter which,

if omitted from the word, would have the least effect on the pronounciation of that word. After the first half of the list had been presented, these Ss were given recognition instructions and told they no longer needed to perform the orienting task. Two groups of intentional learners were run. One intentional group performed the same orienting task as the incidental group; the other intentional group was unencumbered by the orienting task. If the absence of instructions to learn decreases the probability of implicit verbal responses occurring to the critical-stimulus words, then there should be less tendency for incidental learners to incorrectly recognize later words which are presumed to be the same as the Ss' implicit responses to the critical-stimulus words. The results showed that the incidental and intentional learners who performed the orienting task did not differ in their false-recognition responses to associatively related experimental words. The orienting task itself appeared to increase the false-positive rate to phonetically similar words probably because the orienting task induced Ss to respond to the words in the same way it is assumed that Ss respond to nonsense material. Thus, the experiment lent little support to Wallace's hypothesis.

Wallace and Calderone (1969) provided another test of the hypothesis of fewer implicit verbal responses under incidental conditions. In this experiment a free-recall task was used and Ss either learned a list containing conceptually related words or a list of words of low conceptually similarity. Subjects instructed to learn were expected to perform better on a list of high conceptual similarity due to the

implicit occurrence of the concept name, or other category instances during learning. Subjects not instructed to learn and presumably deficient in this type of implicit response were expected to show little difference between learning a high similarity and a low similarity list. In essentially three replications of this basic experiment, Wallace and Calderone found the difference between high and low similarity lists to be greater for intentional than for incidental learners. However, this result was not always supported statistically. The authors concluded that their results were consistent with the interpretation that implicit verbal responses do not occur as readily under conditions of incidental learning as they do under conditions of intentional learning.

In the present study Ss were presented with a list of words under either an incidental or intentional instructional condition. Subjects in both conditions were required to perform an orienting task which involved pronouncing the words. Subjects in the intentional group were told about the ensuing recognition test, while the Ss in the incidental group were told nothing about the memory test. The expectation based on Wallace's interpretation was that there would be a decrease in both associative and conceptual errors under the incidental condition as compared to the intentional condition. A prediction concerning the acoustic errors under incidental and intentional conditions was difficult to make. Since the orienting task required attention to the sounds of the words, acoustic errors might be expected to increase from the intentional to the incidental condition. However, since both groups

were required to perform the orienting task, there may be no change in this type of error. In any case a differential change in error frequencies was clearly predicted with the associative and conceptual errors expected to decrease from the intentional to the incidental condition while the relative frequency of the acoustic errors may either increase or remain unchanged.

Long-Term Retention of Memory Attributes

A final variable manipulated in the experiment was that of length of retention interval. Some Ss received the recognition test immediately after presentation of the learning material; others received their test 48 hours after learning.

There is evidence which suggests that memory attributes may be forgotten at different rates. Bach and Underwood (1970) found associative errors to increase in frequency much more than acoustic errors over a 48-hour interval. These authors attributed this differential increase in errors to differential rates of forgetting of the associative and acoustic attributes with the acoustic being forgotten more rapidly. Other authors (Anisfeld, 1969; Adams, Thorsheim & McIntyre, 1969) have suggested that the acoustic attribute fades more rapidly than associative attributes.

In the present experiment an interaction of errors types and retention interval was expected with the associative and conceptual errors increasing in relative frequency more than the acoustic errors. No firm prediction concerning differences between the associative and conceptual errors over the retention interval was made.

Chapter III

METHOD

In Chapter II various hypotheses related to changes in memory attributes with age, instructional condition, and retention interval were stated. In the following sections the method by which these hypotheses were given experimental test is described.

Subjects

Eighty children from each of Grades 2, 4, and 6 were run in the experiment. Within each grade 40 males and 40 females participated. The second- and fourth-grade children attended an elementary school located in a small-town community in south-central Wisconsin. The sixth-grade Ss attended a middle school located in the same community. Prior to the main experiment, two pilot studies were run in order to check on the suitability of the materials and procedures to be used in the larger study. Altogether, 40 children participated in the pilot studies. These children were enrolled in Grades 2, 4, and 6 in a town very similar to and close by the community in which the main experiment was run.

Task and Materials

All Ss were presented with a list of 45 words to learn. Of these 45 words, 25 were later tested for recognition; the remaining 20 items

were filler words which appeared at the beginning and end of the list to minimize primacy and recency effects. Each of the 25 words was tested by placing it among four distractor words. The S's task was to choose the word he had seen before. The distractors were similar to the correct response (CR) in various ways. One distractor word was acoustically similar to the CR. If S chose this word on the test he made an acoustic (Ac) error. Another distractor word was an associate of the CR. Choosing this word resulted in an associative (As) error. A third distractor was the label for the concept of which the CR was an example. The choice of this word was called a conceptual (C) error. Finally, the fourth distractor word on the test items was a neutral word unrelated to the CR. A response to this word was labeled a neutral (N) error. The CR words along with their distractor words are found in Table 1.

The associates to the CR words were taken from Entwisle's (1966) norms for young children and from Palermo and Jenkins' (1964) norms for fourth- and sixth-grade children and were among the three most common responses to the stimulus word. In the case of five of the CR words (milk, cent, whale, ball and horn) no normative data on associates were available. The associates for two of these words (milk and cent) were taken from the Bach and Underwood (1970) materials. The associates to the other three words resulted from E's judgments which were informally checked with some 20 pilot Ss.

Most of the superordinate terms were taken from Battig and

TABLE 1

Words Used on the Recognition Test

Correct	Conceptual	Associate	Acoustic	Neutral
winter	season	cold	enter	clock
peach	fruit	eat	teach	again
robin	bird	nest	bobbin	letter
black	color	white	back	deep
bee	insect	sting	see	rope
milk	drink	cow	silk	face
bread	food	butter	dead	pipe
cat	animal	dog	pat	visit
cent	money	penny	tent	book
nine	number	ten	mine	open
rose	flower	bush	grows	hill
doll	toy	baby	all	gas
shoe	clothes	foot	sue	cup
boys	people	girls	joys	star
hammer	tool	nail	stammer	king
whale	fish	huge	pail	give
ball	game	hit	call	arm
horn	instrument	blow	torn	blanket
nurse	worker	doctor	purse	fence
square	shape	round	scare	think
chair	furniture	table	share	mud
big	size	little	dig	fire
mother	parent	father	other	pencil
sour	taste	sweet	shower	part
house	building	home	louse	ship

Filler Words			
climb	dust	rub	dream
wait	jump	hide	government
ear	country	empty	short
melt	bridge	try	down
joke	ticket	easy	talk

Montague's (1969) category norms for college students. A few of the categories resulted from E's judgments (taste, size, number, worker). However, a pilot study was run with 20 second-grade Ss to determine the availability of all of the superordinate terms to young children. In the pilot study Ss were given the CR word and three other examples of each category (except in the case of mother, father--parent) and asked to supply the category name. The instance words were printed on cards and shown and read to each S individually. For example, the instances cent, dollar, quarter, dime were given and the number of Ss responding with the category name money was recorded. Thirty-seven sets of instances were tested in this fashion with each child. Twelve of the categories were eliminated from the main study because fewer than 70% of the Ss agreed on the category name. Of the 25 CRs used in the main study, 10 received 100% agreement from the pilot Ss on the category name, 6 achieved 90-99% agreement and 9 were between 70 and 89% agreement. The acoustic distractors resulted from E's judgments as did the neutral words.

An attempt was made to minimize as much as possible certain types of interrelationships among the classes of words across test items. For example, the associative distractors were checked to minimize any acoustic or conceptual relationships with other words in the associative class or with any of the words in the other classes including CR words. Similarly, acoustic distractors were checked for associative and conceptual relationships to other words,

and the conceptual words were checked for extraneous relationships of an acoustic and associative nature. It was impossible to eliminate all such interrelationships, but at least those that remained appeared to be equally distributed across the four distractor sets. Another type of interrelationship across test items was, for example, an acoustic distractor which was acoustically similar to another acoustic distractor or to distractors of other types. This type of relationship was considered less troublesome than the first, but again, these interrelationships were either eliminated, or an attempt was made to equalize them for all distractor classes.

Overall, the classes of words did not differ on Thorndike-Lorge (1944) frequency. Moreover, the word classes were roughly equivalent on parts of speech. Except for one or two exceptions in each word class, all words used in the experiment appeared in the Dale list of 3000 familiar words (Dale & Chall, 1948).

Each CR word was printed in 2-inch letters on an 8x5-inch unruled white card. A single random presentation order of the CR words was used for all Ss. For the recognition test, 8x11-inch cards were marked off into vertically ordered slots numbered 1 through 5. To the right of the number in each slot was printed either the CR or one of its distractors. Over the 25 test items, the CR and each type of distractor appeared equally often in each position on the test cards. Three test orders were constructed. Each test order was random within the restriction that the words

occurring in the first half of the learning trial were equally represented in the first and second half of the test. Similarly, words from the second half of the learning trial appeared equally often in the first and second portions of the test.

Procedure

Subjects were run in groups in an isolated room within each school building. The modal size of a group was five with a few groups of size 3 and 6. The individuals within a group were always in the same grade and were of both sexes. An earlier pilot study, utilizing essentially the same procedure as used in the main experiment, convinced E that even second-grade Ss could understand and attend to the task in a group situation. Since every attempt was made to minimize the sharing of information among children within a group, the unit of analysis for the experiment was the individual S.

During the experimental sessions, the Ss were seated around a large table with E at the head. In the center of the table was a large microphone which was connected to a tape recorder in view of the children. All Ss were first told that E was from the university and was interested in how children in their grade in Wisconsin pronounced certain words. The children were further told that their pronunciation of the words was to be compared to the pronunciation of children in other states. The children were instructed that E would hold up cards one at a time. On each card would be printed

a word which E would pronounce first and then they were to pronounce together as a group. The Ss were told to look carefully at each word as E said it and then say the word as clearly as they could. The children were told that what they said would be picked up by the microphone and recorded on the tape recorder. In reality, although the Ss could see and hear the tape recorder operating, the microphone was nonfunctional so no actual recordings were made. The children in all grades appeared to accept this cover story without qualm. The children in the incidental-learning group were given no further instructions before the learning trial. Intentional learners were told that in addition to studying how they pronounced words, E was also studying how well children in their grade could remember words. Therefore, they were to try to learn the words because later they would be given a test to see if they could pick out the words they had seen from among other words which they had not been shown. For the complete set of instructions used in the experiment see Appendix A.

The words were presented for learning at a 3-second rate. The card containing the word was held up, E pronounced the word, the Ss pronounced the word as a group, and then the next word was presented. The E was well practiced and occasional checks with a stop watch insured that a 3-second rate was closely approximated throughout the experiment.

For the test Ss were given three-page booklets in which to

record their choices. Twenty-five boxes, seven on the first page and nine on the second and third pages, were printed in the test booklets. In the boxes were listed the numbers 1 through 5, corresponding to the numbers on the test cards. The Ss were required to look at the test card, listen while E pronounced each word on the card, and then circle the number in the box which corresponded to the number next to the correct word on the card. The test was unpaced, and E waited until all Ss had made a choice before proceeding to the next test item. Most Ss made their choices quickly. Occasional checks on the response time resulted in an average of 10 to 15 seconds per test item.

The children were cautioned before testing began not to give away the correct answer by saying the word or number aloud or by any other verbal or nonverbal sign. In addition, the Ss were reminded to keep their answer booklets covered.

The test for the immediate-retention group started within two minutes after the end of the learning trial. Subjects in the 48-hour retention group were told that E would meet with them again and that they would have more words to pronounce at that time. At the end of every session all Ss were instructed not to tell their classmates or friends anything about the experiment except that they had pronounced words. Questioning of the children prior to the start of each session and feedback from the teachers in each grade indicated that very little "leakage" of information about the nature of

the experiment occurred over the experimental period of approximately three weeks. It was, of course, of critical importance that Ss in the incidental condition not be contaminated by information concerning the memory test. After each session involving incidental learners, the children were questioned individually as to whether or not they tried to learn the words and whether they had expected a memory test. Only two Ss, one in Grade 4 and one in Grade 6, indicated that they had tried to learn the words because they had expected a memory test. Both children were replaced with alternate Ss.

After all 25 words had been tested, all Ss were given a second test trial in which they were required to choose a different word than they selected on the first test. For information concerning the second test trial see Appendix B.

Experimental Design

The design of the experiment consisted of a factorial combination of three variables: grade (2, 4, and 6), instructional condition (incidental and intentional) and retention interval (immediate and 48 hours). Within each grade, 10 males and 10 females were randomly assigned to each of the four combinations of instructions and retention interval. The Ss assigned to a given experimental condition were randomly formed into groups for running. The experimental period lasted approximately three weeks. Randomized-block schedules which ran concurrently in the three grades were devised

such that a group within each condition was run before a condition was repeated. Thus, all conditions were equally represented in each portion of the experimental period.

Chapter IV

RESULTS AND DISCUSSION

For each S the numbers of errors of each type were tabulated and then expressed as proportions of the total errors for that S. The mean proportions of each type of error as a function of grade and instructions for the immediate and 48-hour retention conditions are shown in Table 2. The absolute frequencies of errors were converted to proportions so that Ss would receive equal weight regardless of their absolute numbers of errors. The hypotheses tested in the experiment involved the changes in the relative frequency of different types of errors as a function of age and other variables. Bach and Underwood (1970) also argued that it is the relative frequencies of different types of errors as a function of grade which are of concern and not the absolute frequencies. These investigators used the absolute numbers of errors as dependent measures and then looked at the interaction of grade and types of errors while ignoring the absolute levels of the error curves. However, it seemed to this investigator that the use of proportions directly expresses the frequencies of the error types in terms relative to one another and thus are the more appropriate dependent variables.

The acoustic, conceptual and associative error proportions were

TABLE 2

Mean Proportions and Standard Deviations of Acoustic (Ac), Conceptual (C), Associative (As), and Neutral (N) Errors as a Function of Grade, Instructions and Retention Interval

	Immediate Retention				48-Hour Retention			
	Ac	C	As	N	Ac	C	As	N
Incidental								
Mean	.29	.17	.28	.15	.15	.27	.33	.25
SD	.29	.19	.29	.26	.09	.10	.09	.09
Grade 2								
Intentional								
Mean	.33	.27	.24	.21	.12	.27	.29	.32
SD	.26	.18	.22	.15	.09	.10	.14	.15
Grade Mean	.31	.22	.26	.18	.13	.27	.31	.28
Incidental								
Mean	.24	.26	.31	.19	.12	.34	.27	.26
SD	.19	.17	.23	.16	.09	.14	.12	.11
Grade 4								
Intentional								
Mean	.23	.27	.25	.19	.16	.35	.21	.27
SD	.21	.21	.21	.19	.08	.18	.10	.14
Grade Mean	.24	.27	.28	.19	.14	.34	.24	.26
Incidental								
Mean	.20	.35	.24	.20	.10	.33	.31	.25
SD	.25	.21	.22	.18	.09	.12	.14	.14
Grade 6								
Intentional								
Mean	.16	.32	.26	.16	.13	.31	.27	.29
SD	.21	.33	.23	.18	.09	.13	.14	.13
Grade Mean	.18	.33	.25	.18	.11	.32	.29	.27

linearly combined into two orthogonal contrasts which then became the dependent variables in the multivariate analysis of variance. One dependent variable was the contrast formed by taking the average of the conceptual and associative error proportions minus the acoustic error proportion ($\overline{C + As} - Ac$). The other dependent variable was the difference between the conceptual and associative error proportions (C - As). The use of these contrasts among the error proportions as dependent variables in the analysis allowed the testing of the predicted interactions of error types with the independent variables of grade, instructions and retention interval. The multivariate analysis of variance was carried out using Finn's (1968) computer program. The results of the multivariate analysis of the error-combination scores are found in Table 3[1]. The significance level adopted for the multivariate tests was .05. For the interpretation of the univariate F tests, the alpha

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[1]Careful inspection of Table 2 reveals that the standard deviations of the error proportions for the groups at the 48-hour retention interval were consistently smaller than those for groups tested immediately. An inspection of the variances of the two error-combination scores used as dependent variables showed in both cases greater variance in immediate retention than in 48-hour retention. In order to determine the effects of this heterogeneity of variance, a transformation was performed on the error proportions in order to equalize the variance at the two retention intervals. The transformation, in simplified terms, involved multiplying the scores at the 48-hour retention interval by a constant estimated from the ratios of the variances at the two retention intervals (see Sheffe, 1959, chapter 10). A weighted least-squares analysis of variance was then carried out on the transformed error proportions, again using the two linear combinations of errors as dependent variables. The results of this analysis were in essential agreement with the multivariate analysis using the original error proportions. Thus, the results of the analysis on the untransformed scores has been reported.

TABLE 3

Multivariate and Univariate Analyses of Variance of Error-Combination Scores[1]

Source	Multivariate Analysis F	df	Probability	Contrast	Univariate Analysis F	df	Probability
Grade (linear)	5.06	2,215	<.007*	$\overline{C+As}$-Ac	5.92	1,216	<.016*
				C-As	3.81	1,216	<.052
(Quadratic)	0.44	2,215	<.645	$\overline{C+As}$-Ac	0.03	1,216	<.957
				C-As	0.88	1,216	<.348
Instructions	0.84	2,215	<.431	$\overline{C+As}$-Ac	0.26	1,216	<.613
				C-As	1.49	1,216	<.224
Retention Interval	6.65	2,215	<.002*	$\overline{C+As}$-Ac	12.88	1,216	<.0005*
				C-As	0.29	1,216	<.589
Grade (L) x Instructions	0.60	2,215	<.550	$\overline{C+As}$-Ac	0.11	1,216	<.737
				C-As	1.06	1,216	<.305
Grade (Q) x Instructions	0.15	2,215	<.856	$\overline{C+As}$-Ac	0.20	1,216	<.656
				C-As	0.13	1,216	<.722
Grade (L) x Retention	1.44	2,215	<.240	$\overline{C+As}$-Ac	2.50	1,216	<.115
				C-As	0.31	1,216	<.581
Grade (Q) x Retention	1.48	2,215	<.228	$\overline{C+As}$-Ac	0.12	1,216	<.725
				C-As	2.91	1,216	<.089
Instructions x Retention	0.26	2,215	<.774	$\overline{C+As}$-Ac	0.50	1,216	<.481
				C-As	0.09	1,216	<.925

[1]The multivariate and univariate tests for the two three-way interactions were all less than 1.00.
*Significant at the level indicated

level was scaled down in order to control the error rate for the tests considered jointly. Following a strategy suggested by Miller (1966), the significance level for the individual F tests was set at α/k where k is the number of tests being interpreted. For each multivariate F test, a univariate test of each of the two error-combination scores was carried out. Therefore, the significance level for the individual F tests was set at .025 in order to maintain an overall error rate of .05.

In Table 3 are shown the multivariate and univariate tests of the error-combination scores for the factors of grade, instructions, retention and their interactions. Sex was included as a variable in the analysis in order to remove the variance due to this factor from the error term. In the sections which follow the findings related to the variables of grade, instructions and retention interval are discussed.

Grade

The multivariate F for the linear grade effect was significant. Univariate F statistics were computed for each error-combination variable. Only the univariate F for the $\overline{C+As}$-Ac contrast was significant suggesting that this element of the vector accounted for most of the variation in the mean vectors. In Figure 1 are shown the mean proportions of each type of error as a function of grade. The trends in the error curves are readily apparent. The proportion of acoustic errors decreases with increasing grade. The proportion of conceptual errors increases with grade. The relative frequency of associative errors appears to decrease slightly from Grade 2 to Grade 4 and then remain

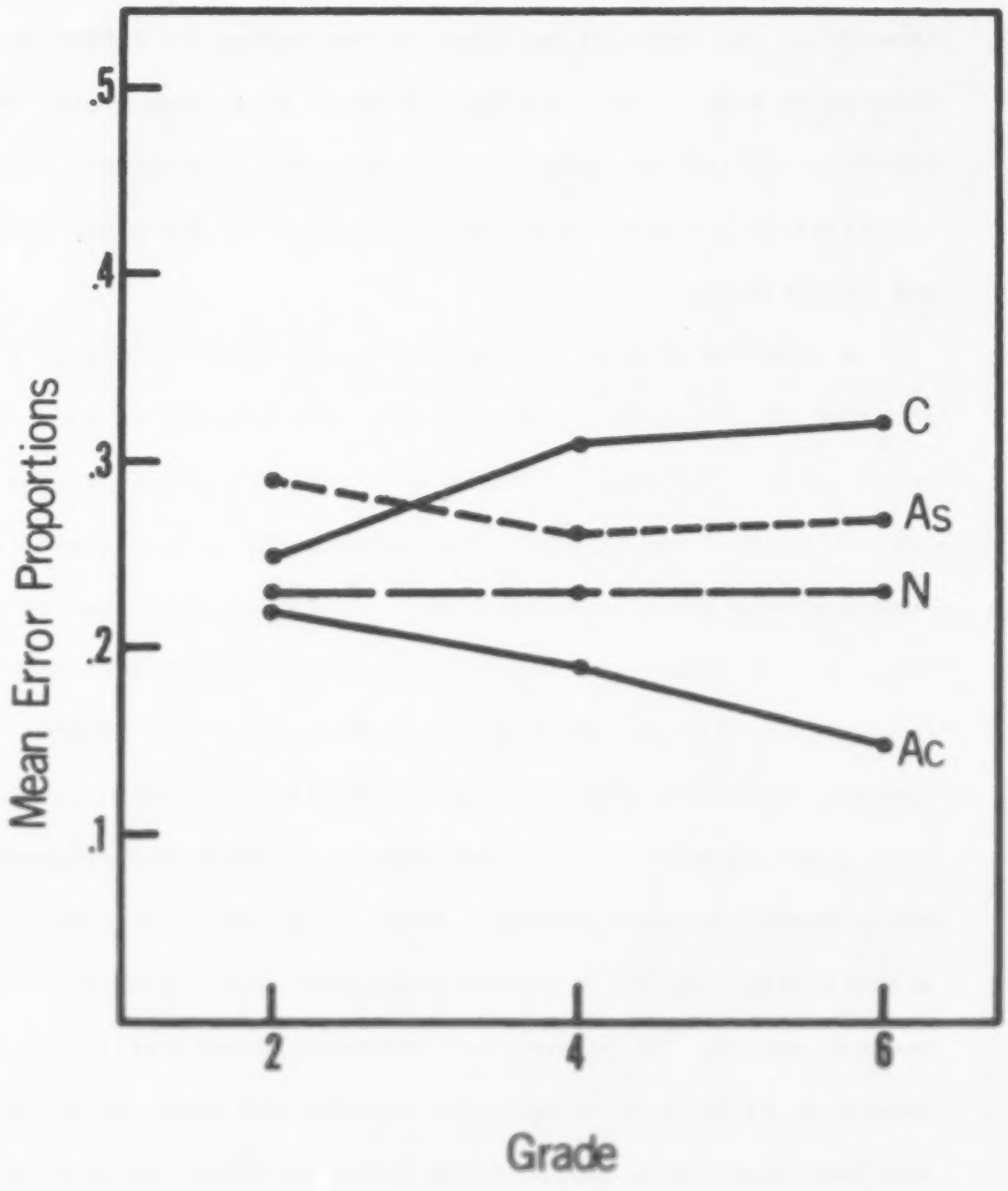

Figure 1. Mean proportions of conceptual (C), associative (As), acoustic (Ac), and neutral (N) errors as a function of grade summed over retention interval

about the same from Grade 4 to Grade 6. The significant $\overline{C+As}$-Ac contrast reflects the tendency for the error curves to diverge in the predicted manner as a function of grade. While the slopes of the conceptual and associative error curves appear to differ with the conceptual error curve showing a steeper rise with grade, the univariate F for the C-As contrast was not significant. The multivariate F for the quadratic component of the grade effect was not significant.

A puzzling feature of the curves contained in Figure 1 is the position of the acoustic error curve with respect to the neutral error curve. The neutral terms were included on the recognition test as control words; the curve showing the proportion of neutral errors should serve as a baseline. Positive deviations of the other error curves from the neutral error curve thus reflect the tendency for Ss to be distracted by words bearing a certain similarity to the correct response. This distracting ability of words on the recognition test items in turn reflects the manner in which the original words were encoded during learning. Thus, if Ss were encoding words acoustically, one would expect a greater proportion of acoustic than neutral errors. If Ss were not encoding acoustically then one would expect no difference between the neutral and acoustic error proportions. The fact that the acoustic error curve is below the neutral curve, particularly in view of the strong downward trend in the acoustic curve across grades, is, logically speaking, an anomalous result.

The curves in Figure 1 were obtained by summing across retention interval. The error curves as a function of grade for the immediate retention condition, shown in Figure 2, probably reflect more accurately the memory attributes developed during learning. In the second grade the acoustic errors accounted for the largest proportion of errors with the associative errors accounting for a greater proportion than the conceptual errors. In Grade 4 the associative and conceptual errors occurred with the same relative frequency which was greater than that of the acoustic errors. In Grade 6 the conceptual errors accounted for the greatest proportion of errors with associative errors next and acoustic errors least. Clearly, the trends of the conceptual, associative and acoustic error curves across grades in immediate retention support the developmental hypothesis offered earlier. Further, in immediate retention all of the error curves fell above the curve for neutral errors with the exception of the acoustic error at Grade 6. From Figure 2 one could conclude that conceptual, associative and acoustic attributes were developed during learning, and that different attributes were dominant in the three grades.

In Figure 3 are found the error curves as a function of grade at the 48-hour retention interval. Neither the multivariate tests nor the univariate F statistics for the linear and quadratic components of the grade by retention-interval interaction were significant. Thus, the tendency for the conceptual and associative curves to diverge from the acoustic error curve over grades was still present at the 48-hour interval. However, the relative positions of the error curves were quite different at the two retention intervals. After 48 hours the

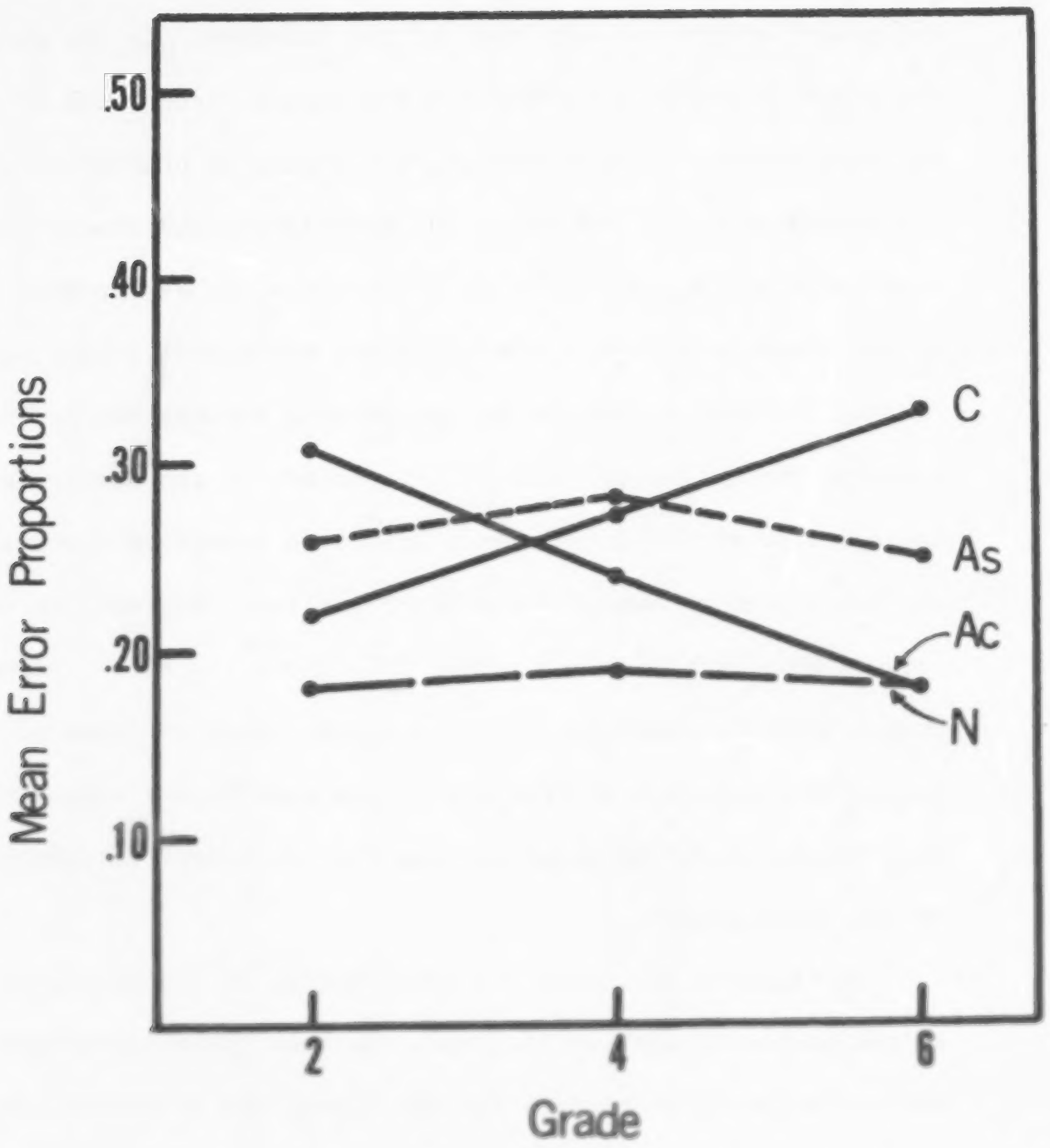

Figure 2. Mean proportions of each type of error as a function of grade in immediate retention

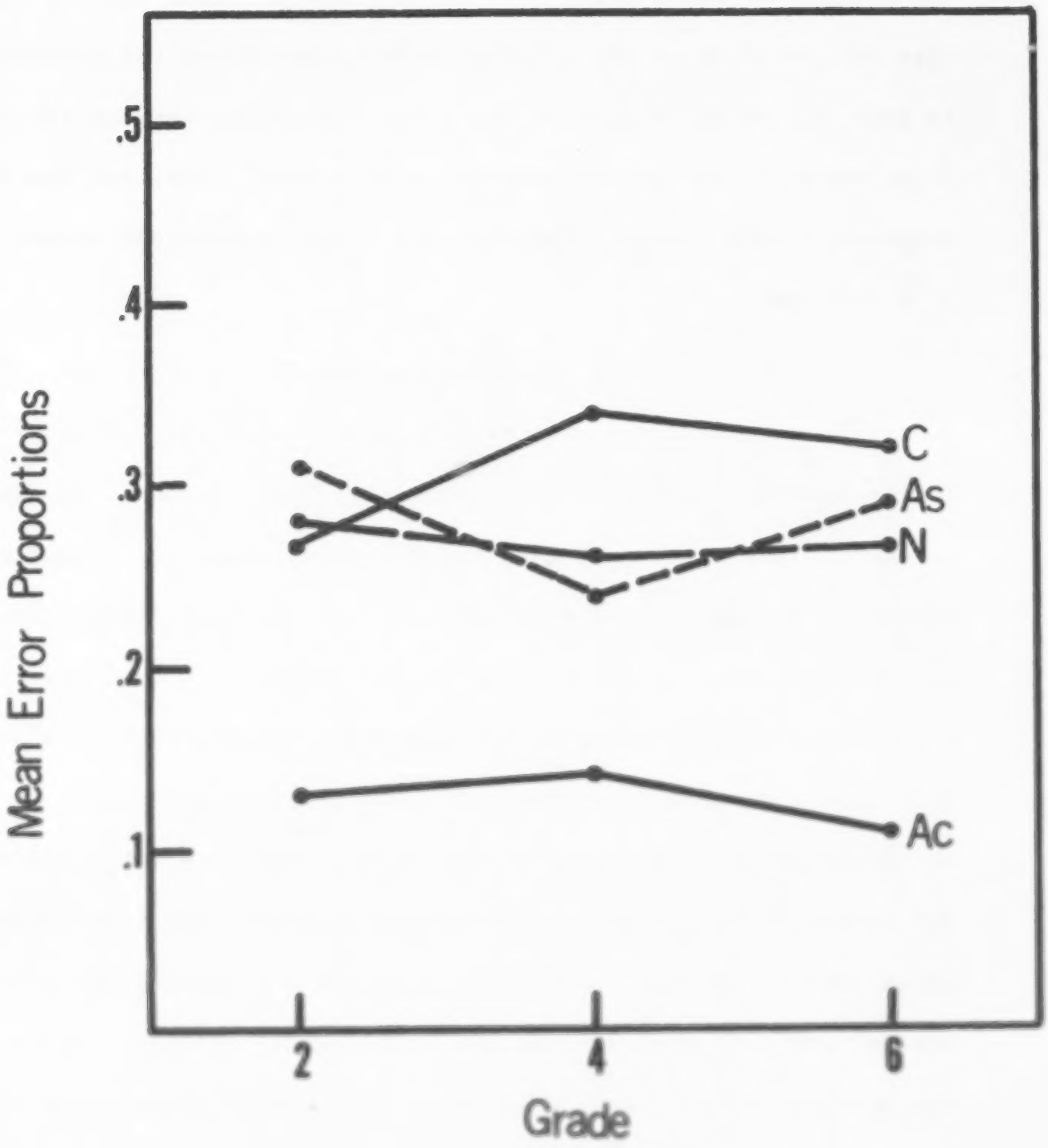

Figure 3. Mean proportions of each type of error as a function of grade in 48-hour retention

acoustic error curve was far below the neutral error curve for all grades, whereas in immediate retention the acoustic error curve was clearly above the the neutral curve at least for Grades 2 and 4. This finding suggests that the position of the acoustic error curve below the neutral curve in Figure 1 is due mainly to the large difference between the two error proportions in the delayed retention condition. Further, the finding suggests a differential change in the error proportions across the retention interval.

Retention Interval

Figure 4 shows the mean proportions of each type of error for Ss in the immediate and 48-hour retention groups. Because the grade by retention-interval interaction was not significant for either of the dependent variables, the error proportions were combined across grades at each retention interval. The curves in Figure 4 show more clearly the finding already noted in the previous section. Subjects in the 48-hour retention condition tended to have a higher proportion of conceptual and associative errors than did Ss in the immediate retention condition. The multivariate F test for the retention effect was significant; the univariate F test for the $\overline{C+As}$-Ac contrast was significant; the univariate test of the C-As contrast was not significant. Figure 4 again shows the acoustic error curve to be below the neutral error curve after the 48-hour interval. This latter result is not in agreement with previous studies. With second- and sixth-grade Ss, Bach and Underwood (1970) found that the acoustic error curve was above the neural error curve in immediate retention and after 48 hours. Underwoodand Freund (1968b) using adult Ss found the frequency of neutral and acoustic errors to be essentially equal in immediate retention and after 24hours.

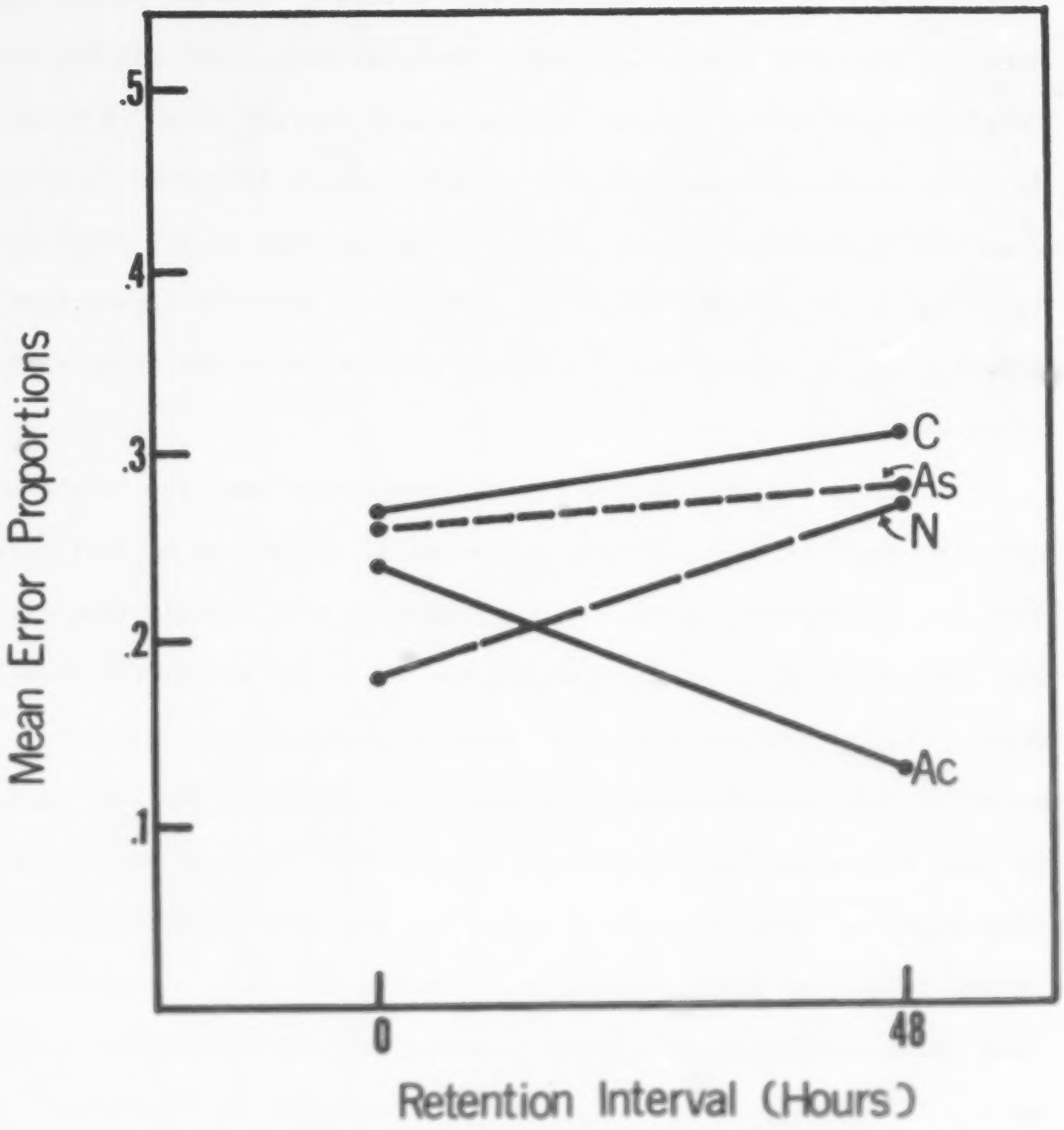

Figure 4. Mean proportions of each type of error as a function of retention interval

The mean error proportions in Figure 4 do not reflect the amount of forgetting which occurred over the 48-hour interval. On the immediate test, roughly 26% of the Ss' responses were errors. On the delayed test, approximately 60% of the responses were errors. Clearly, forgetting occurred over the 48-hour interval. However, forgetting was not nearly complete since 40% of the Ss' responses were correct after 48 hours. In terms of absolute numbers, the acoustic errors increased slightly over the retention interval. However, the increase in all other error types was so much greater than the increase in acoustic errors that the acoustic errors accounted for a lesser proportion of the total errors after 48 hours.

The differential change in error proportions over the retention interval could be attributed to differential forgetting of attributes. That is, the acoustic attribute was forgotten more rapidly than either the conceptual or associative attributes which did not differ from one another in the rate at which they were forgotten. The reasoning on which this interpretation is based is as follows. The fact that Ss made conceptual and associative errors after 48 hours at a relatively high rate must mean that the conceptually and associatively similar words on the tests were still serving as effective distractors suggesting that these attributes were still a part of the memory for the correct word. In immediate retention, which is considered as the measure of the attributes developed in learning, the acoustically similar words were roughly comparable to the conceptual and associative words in their ability to distract the Ss on the test. However, after the 48-hour interval the acoustic errors fell far below the conceptual and associative

errors. This result suggests that Ss at the longer retention interval were not as subject to interference from the acoustic distractor as Ss in the immediate retention condition because the acoustic attribute developed during learning had faded.

Opposed to the interpretation of differential forgetting of attributes is the fact that the acoustic error curve fell below the neutral curve after the 48-hour interval. If the acoustic attribute faded over the retention interval, then the acoustic distractors on the test items should function essentially as neutral words. That is, there should be no difference between the acoustic and neutral error curves. That Ss made fewer acoustic than neutral errors could mean that the Ss in the 48-hour retention condition developed some kind of strategy which allowed them to eliminate the acoustically similar words as choices on the recognition test. In the final section of this chapter, the evidence related to strategies is explored.

Instructions

There was no significant variation among the mean vectors due to instructional conditions. Neither of the univariate tests of the error-combination variables was significant. Moreover, none of the tests for the interaction of instructions with the other variables of grade and retention interval were significant. Figure 5 shows the proportions of conceptual, associative and acoustic errors as a function of instructional condition. There was a slight tendency for the conceptual and associative error proportions to be smaller

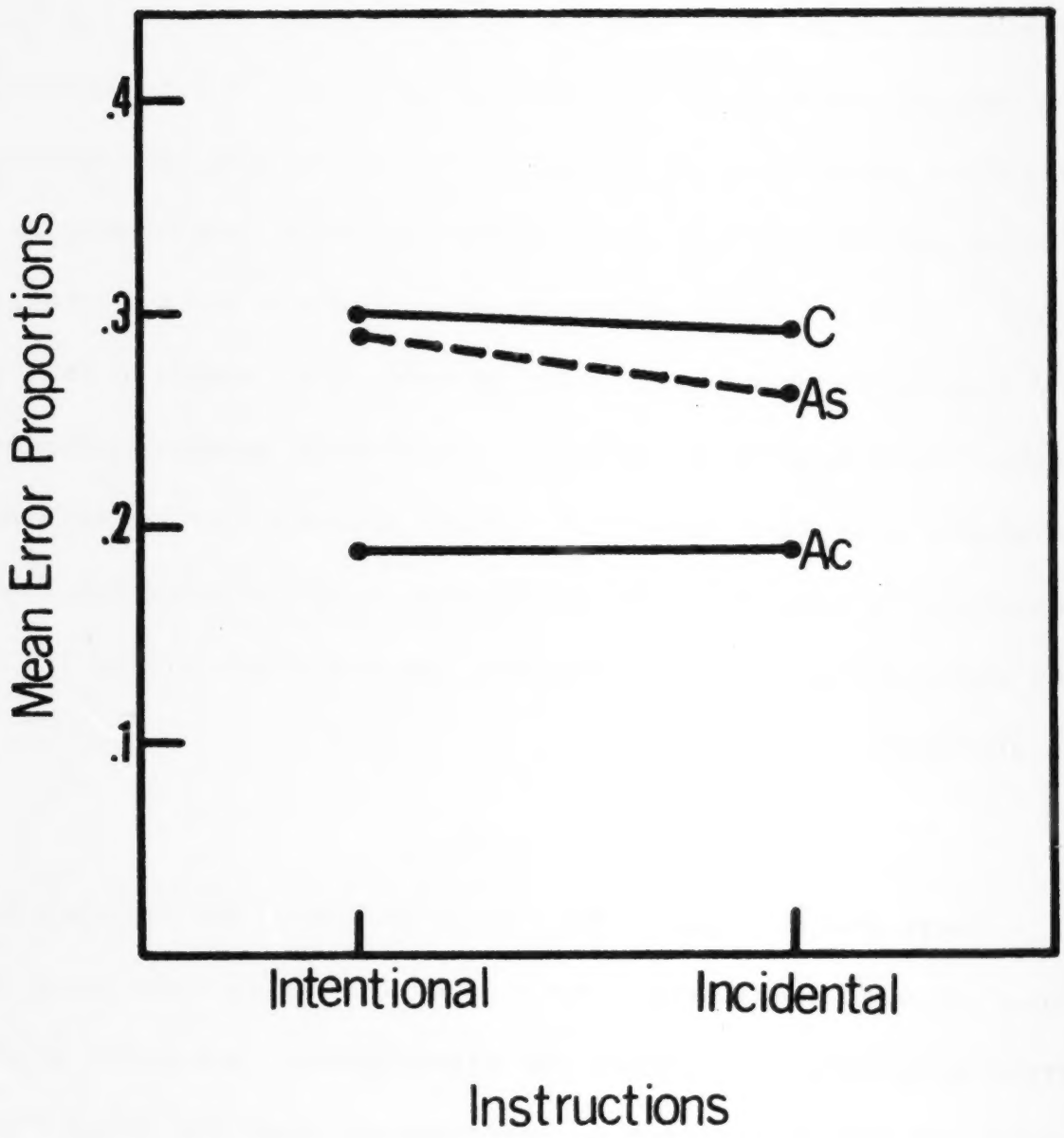

Figure 5. Mean proportions of errors as a function of instructional condition

in the incidental condition than in the intentional condition. The proportion of acoustic errors appears to have remained constant across the instructional conditions. Thus the predicted trends in error curves as a function of instructions occurred, but they were very weak, lending little support to the hypothesis of fewer implicit verbal responses under incidental instructions than under intentional instructions.

It appears that under incidental instructions, errors of all types were reduced, at least for younger Ss. This is reflected by the mean total errors in immediate recognition. In Grade 2 intentional learners made 7.35 errors; incidental learners made 4.60 errors. In Grade 4 the mean total errors for the intentional Ss was 8.00; for the incidental learners the mean was 7.20. In Grade 6 intentional learners made 6.36 errors while the incidental learners made 7.55 errors. However, the test of the interaction of instructions and grade for total errors only approached significance ($F = 3.13$; $df = 1, 216$; $p < .078$).

Subject Strategies

The result noted previously that the acoustic error curve was below the neutral error curve at the 48-hour retention interval led to the speculation that Ss might have employed a strategy for selecting their responses on the test. The test items were constructed in such a way that it was possible for Ss to completely isolate the correct response. The strategy for choosing the correct word would be to choose one of the rhyming words which also had an associate and a superordinate term among the words on the test items. It is highly improbable that Ss employed this complete strategy. Even though the test was unpaced, the time that Ss actually spent in making their responses was relatively

short. It would seem that longer response times would be necessary for the development and employment of a fairly complex strategy. Also, the lack of feedback on the test would not provide the optimal condition for the development of such a strategy. The fact that the error rates on the test (26% at the immediate and 60% at the 48-hour interval) were sizeable also argues against the notion that very many Ss were employing a strategy which allowed isolation of the correct response. Finally, if very many Ss employed such a complete strategy one would expect the relationship between grade and types of errors made in recognition to be obscured. This was not the case; strong evidence was found for the divergence of acoustic and other types of errors as a function of grade.

Even if Ss did not employ a strategy which allowed them to isolate the correct response, they may have developed strategies which allowed them to consistently eliminate one or more of the words on the test items. The result shown in Figure 4, the fact that the proportion of acoustic errors fell below the proportion of neutral errors at the 48-hour interval, is the result that must be explained. In the remainder of this section several hypotheses which account for this finding are offered and the evidence for and against each hypothesis is discussed.

The first hypothesis assumes, as have previous investigators (Bach & Underwood, 1970; Underwood and Freund, 1968b), that the neutral error curve was in fact a baseline or control curve. Thus, the fact that the acoustic error curve fell below the neutral error curve at the 48-hour interval cannot be attributed merely to forgetting of the acoustic attribute. If this were the case, the proportion of acoustic errors should equal the proportion of neutral errors after 48 hours. To

account for the difference between the neutral and acoustic error curves, the hypothesis assumes that Ss in the 48-hour retention group employed a guessing strategy on the test items for which they could not immediately identify the correct response. The guessing strategy was to limit the number of response alternatives by ruling out words which sounded alike. The hypothesis further assumes that Ss in the immediate-retention group did not tend to develop guessing strategies because on most test items (74%) the correct response was immediately identified. Thus, these Ss had fewer occasions or trials in which to develop guessing strategies. As intended, the hypothesis does account for the position of the acoustic curve above the neutral curve in immediate retention and below the neutral curve after 48 hours. Moreover, the assumptions of the hypothesis give rise to several new and testable predictions.

If S employed the strategy of ruling out rhyming words on those test items on which he was guessing, then he had no basis for distinguishing the correct response from the acoustic distractor, and thus he eliminated both. Assuming that any strategy develops over time, with practice, one would expect fewer correct responses on the second half of the test items than on the first half if Ss were ruling out rhyming words. At the 48-hour interval the mean number of correct responses per item in the second half of the test was 47.08; the mean number correct per item in the first half of the test was 52.75. Thus, there was a decrease in the number of correct responses in the second half of the test lending support to the hypothesis. The hypothesis also assumes that Ss in the immediate retention condition did not employ such a strategy. However, these Ss showed roughly the same decrease in correct responses between

the two halves of the test as Ss assumed to be employing the strategy. Subjects in immediate retention gave a mean number of 90.58 correct responses per item on the first half versus 86.23 correct responses per item in the second half of the test. At best, the evidence for the hypothesis based on the distribution of correct responses over the two halves of the test is equivocal.

A second prediction derived from the hypothesis that Ss at the 48-hour interval eliminated rhyming responses, is that the difference between the neutral and acoustic error frequencies should be greater in the second half of the test than in the first half of the test. Again, this prediction is based on the assumption that Ss should become more proficient in applying a guessing strategy over test items. In the top part of Figure 6 are plotted the mean numbers of acoustic and neutral errors at the immediate and 48-hour retention intervals for the first half of the test items. In the bottom part of Figure 6 are plotted the means for the second half of the test items. The difference between the neutral and acoustic errors does appear more pronounced in the second half of the test as compared to the first half for the Ss at the 48-hour interval. However, the greater difference between the frequencies of the two types of errors on the second half of the test appears to be due mainly to the greater frequency of neutral errors in the second half rather than to a lesser frequency of acoustic errors in the second half as compared to the first half. One would expect a decline in acoustic errors over test items if Ss were developing the strategy of eliminating rhyming words.

A final prediction derived from the hypothesis that Ss employed the strategy of eliminating rhyming words is that Ss making few correct

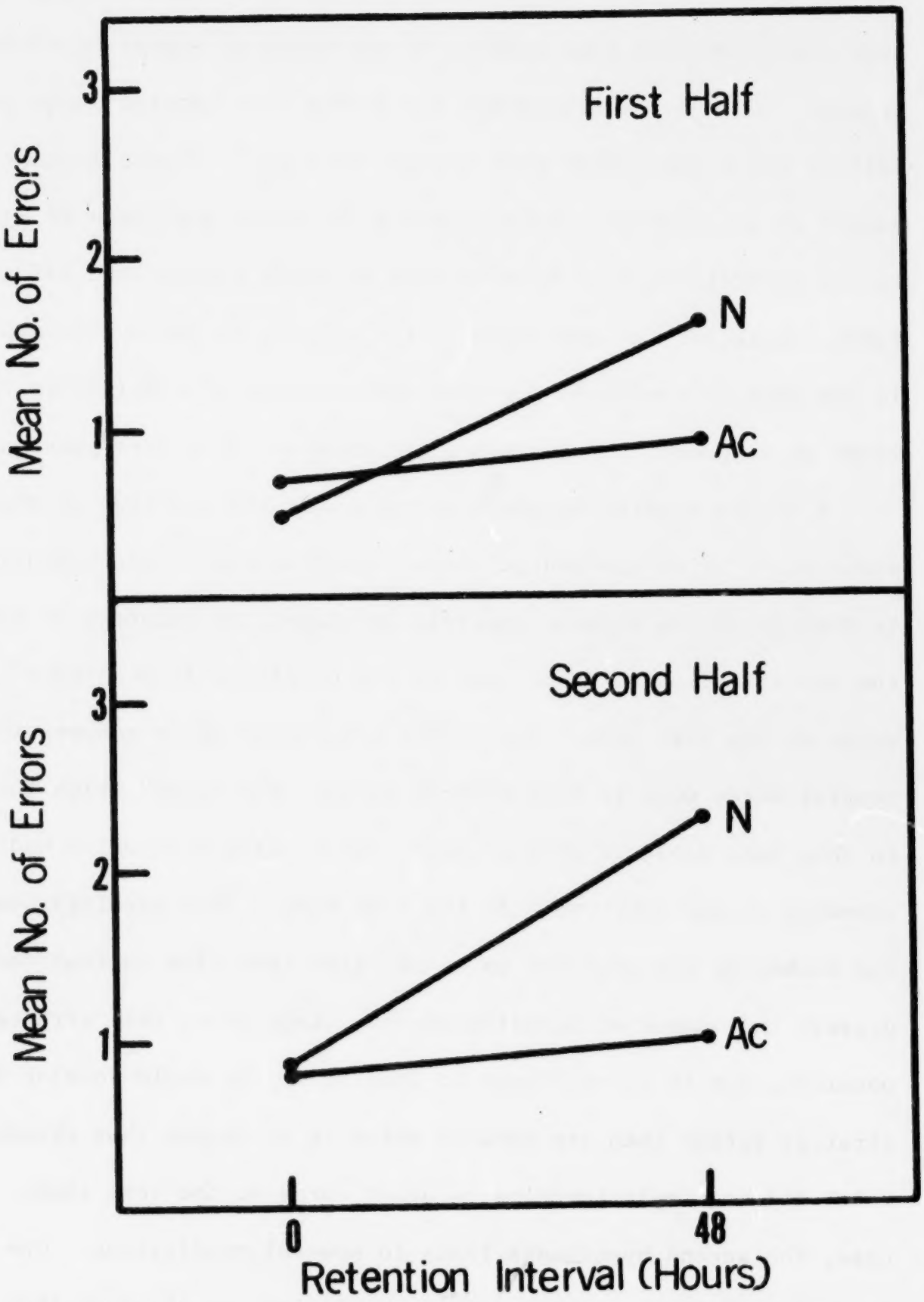

Figure 6. Mean numbers of acoustic and neutral errors as a function of retention interval for the first and second halves of the test items

responses over the 25 test items should make fewer acoustic errors than Ss making many correct responses. To test this prediction, Ss in the 48-hour condition were rank ordered on the basis of number of correct responses. Those Ss falling above the median were labeled "good Ss"; those falling below the median were termed "poor Ss." Figure 7 shows the mean number of acoustic and neutral errors for these two types of Ss. Contrary to the prediction, poor Ss made more acoustic errors than did good Ss. Taken altogether the data lend little support to the hypothesis that Ss in the 48-hour condition employed the strategy of eliminating rhyming words as responses on the test items on which they were guessing.

A second hypothesis which accounts for the position of the acoustic error curve below the neutral error curve at the longer retention interval is that Ss at the 48-hour interval developed the strategy of eliminating the acoustic distractor because it was unrelated in meaning to the other words on the test item. The second hypothesis again assumes that the neutral words were in fact control words. The "rule" which the Ss follow in this case would be to eliminate that rhyming word which had no relationship to any other word on the test item. This strategy would reduce the number of alternatives on a test item from five to four and also depress the number of acoustic errors. Logically, this strategy is possible, but it is difficult to imagine why Ss would develop this strategy rather than its inverse which is to choose that rhyming word which did bear relationships to other words on the test item. In any case, the second hypothesis leads to several predictions. One prediction is that as Ss become proficient in employing the strategy they could effectively eliminate one wrong alternative on the test items. Thus, one would expect the probability of guessing the correct response to

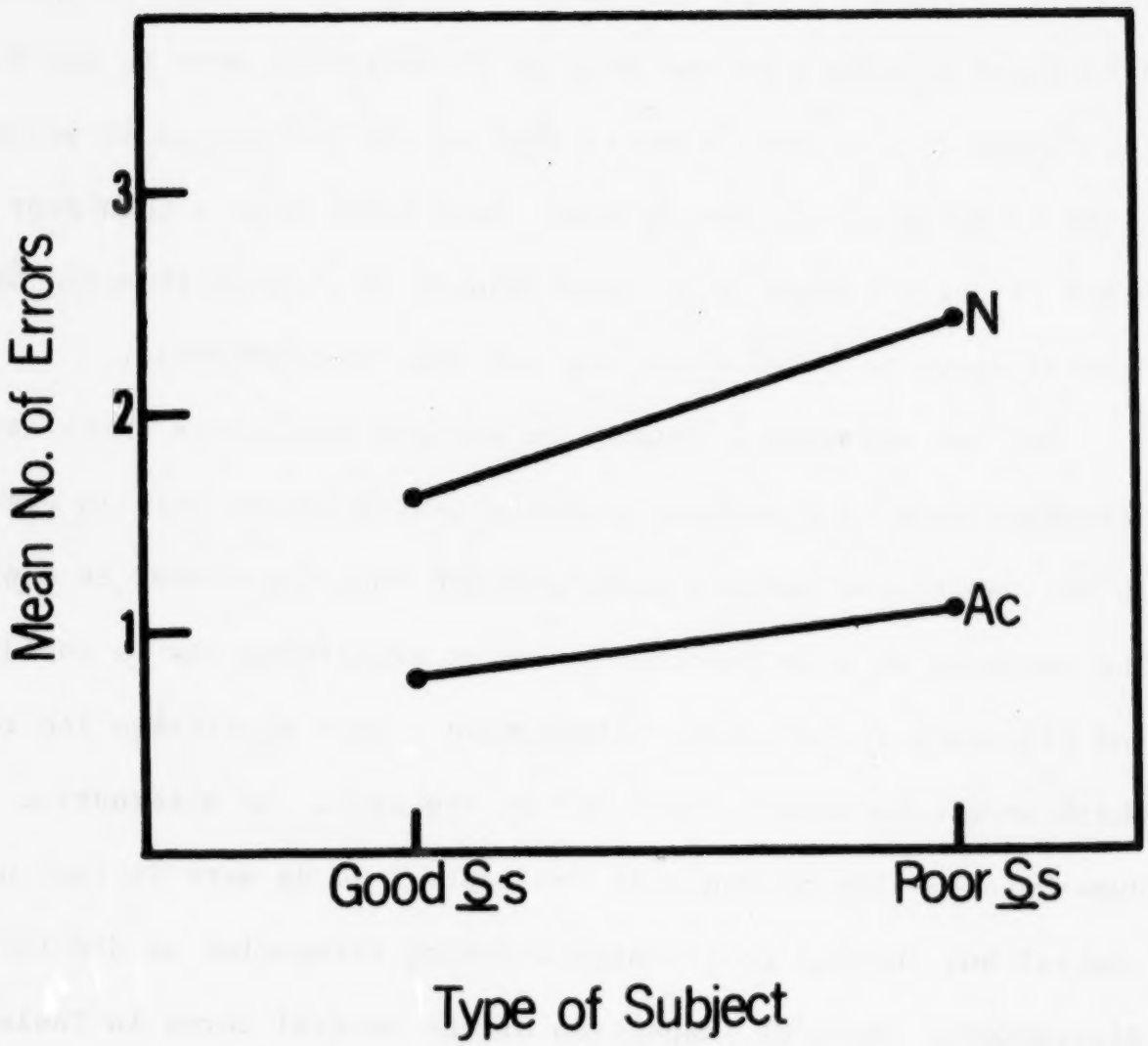

Figure 7. Mean numbers of acoustic and neutral errors for good and poor subjects at the 48-hour retention interval

increase over items. It has already been shown that the average number of correct responses for items in the second half of the test is less than for items in the first half of the test. The strategy of ruling out the acoustic distractor should increase the probability of a correct response. Subjects with a high number of correct responses thus should have fewer acoustic errors than Ss who had a low number of correct responses. This result has already been shown in Figure 7. However, the good Ss in Figure 7 also had fewer neutral errors than the poor Ss and the difference between good and poor Ss is reflected more in the difference in the frequency of neutral errors than in the difference in acoustic errors. Since by definition, good Ss have fewer total errors than poor Ss, the slope of the acoustic error curve should be steeper than the slope of the neutral curve to provide any support for the hypothesis.

The two hypotheses related to subject strategies which have been discussed have both assumed that the neutral words were in fact unrelated in any way to the correct responses and thus functioned as control words. The emphasis of both hypotheses was on explaining how Ss could discriminate and eliminate the acoustic alternative. Both hypotheses led to predictions which were only weakly borne out by the data. An alternative to these hypotheses is the notion that the neutral words were in fact not really neutral but instead represented encoding categories as did the other distractors. Careful inspection of the neutral terms in Table 1 did not reveal to this investigator any consistent similarity relationship between the neutral and correct responses on the different test items. Thus, if the neutral words did represent encoding categories these categories were idiosyncratic, differing from test item to test item and from S to S.

Also, judging from Figure 1, Ss in different grades did not differ in the development of memory attributes represented by the neutral words. Admittedly, the notion of the neutral words representing idiosyncratic encoding categories is a rather vague one which does not lend itself easily to empirical test. It was thought that an analysis of the test items over Ss might reveal a tendency for some neutral words to be chosen with greater frequency than others. Some commonality of relationship between the correct word and the neutral distractors chosen with high frequency might then become apparent.

The distribution of neutral choices over the 25 test items was examined for three randomly selected samples of 10 Ss at each grade level. For each sample of 10 Ss, the frequency of neutral choices was computed for each of the test items. The frequency of neutral responses on each test item was then compared across the three samples within a grade. No pattern emerged from this analysis at any grade level. In general, neutral responses were rather equally distributed over the test items, and if one test item did have a high frequency of neutral responses for one sample, it was no more likely to have a high frequency than a low frequency of neutral choices in the other samples.

In conclusion, it must be said that no clear resolution of the puzzle presented by Figure 4 has been reached. Evidence for the type of strategies which would result in an avoidance of the acoustic distractor was not present in the data. The hypothesis that the neutral words represent encoding categories can not really be tested. However, if

one accepts the notion that the neutral curve does not represent a real baseline but instead reflects the Ss' use of idiosyncratic encoding categories, then the findings for the 48-hour interval are not so puzzling One can explain the results in Figure 4 by differential forgetting of attributes. The acoustic attribute is forgotten more rapidly than the conceptual and associative attributes and faster than the various attributes represented by the neutral words. But this interpretation also presents problems. If the neutral curve is not a baseline, then how can one assess the extent to which Ss developed the memory attributes of interest, namely the acoustic, the conceptual and associative attributes? In fact without a baseline can one infer that any of these attributes were developed during learning? Surely, the rather clear trends in the acoustic, conceptual and associative error curves as a function of grade argue that Ss did develop these attributes in learning and that as predicted younger Ss utilized the acoustic attribute more and the conceptual and associative attributes less than older Ss. If the memory attributes in question were not developed during learning, these trends could hardly have occurred. One could also argue that if the acoustic attribute is the dominant or preferred attribute (see Appendix B) for second-grade Ss in immediate memory and if the acoustic attribute is forgotten by all Ss more rapidly than the other attributes, then the recognition performance of the second-grade Ss should show more deterioration over the 48-hour interval than the performance of the older Ss. This is because the younger Ss should lose more relevant information over the retention interval than the older

Ss. Figure 8 shows the mean total errors for Ss in the three grades in immediate and delayed retention. In immediate recognition the second-grade Ss were slightly superior to the fourth- and sixth-grade Ss. After 48 hours, the second graders made more errors in recognition than the older children. The test of the grade by retention-interval interaction for total errors was significant (F= 6.00; df=1,216; p<.015). This result supports both the conclusion that the immediate memory of second-grade Ss is dominated by the acoustic attribute and the conclusion concerning the more rapid forgetting of the acoustic attribute.

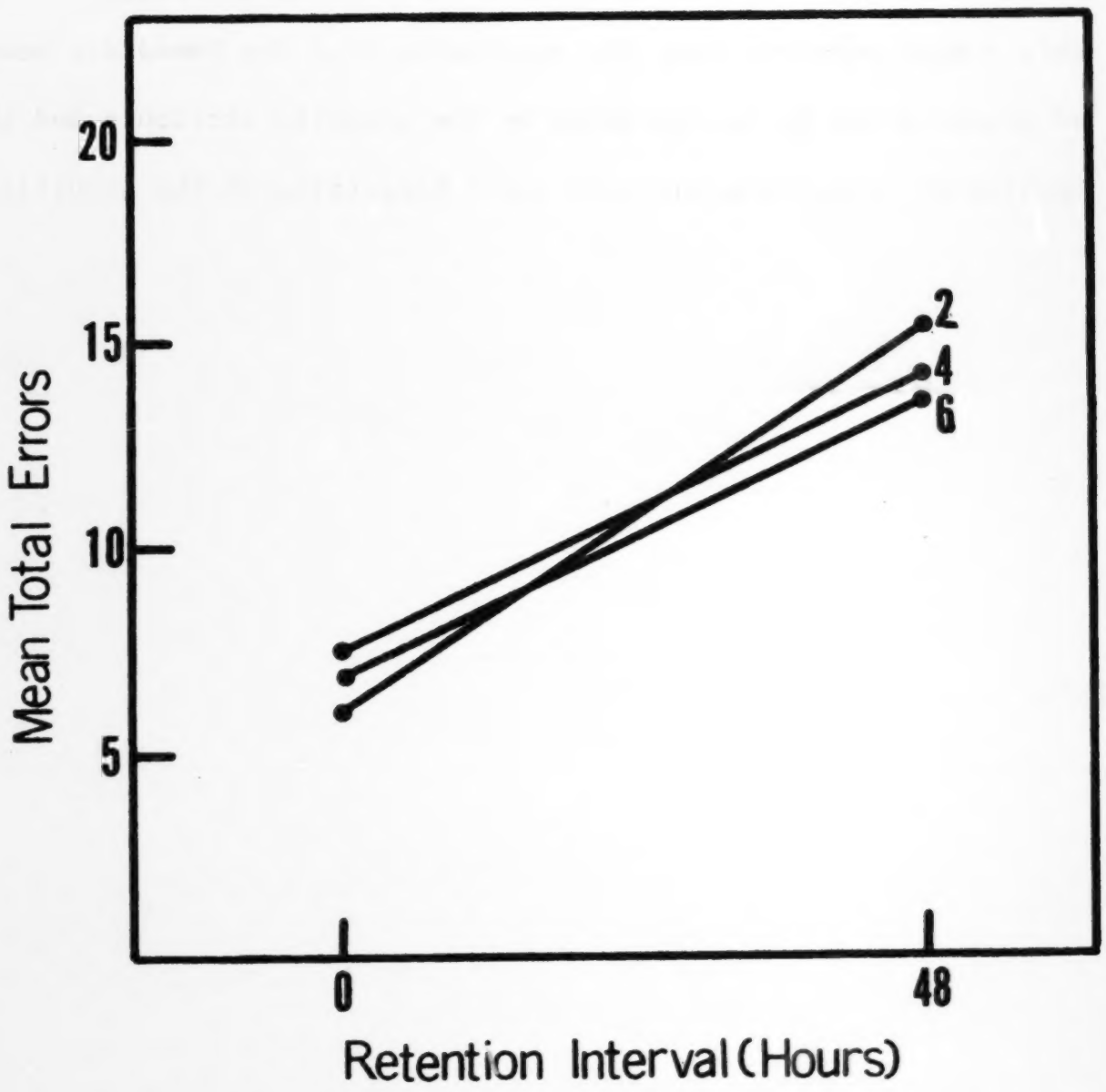

Figure 8. Mean total errors as a function of grade and retention interval

Chapter V

CONCLUSIONS

One major conclusion from the experiment is that the immediate recognition memory of second-grade Ss is dominated by the acoustic attribute. This attribute plays a progressively lesser role in the recognition memory of fourth- and sixth-grade Ss. This conclusion is in agreement with previous findings concerning developmental changes in memory attributes (Bach & Underwood, 1970; Felzen & Anisfeld, 1970). A second, related, conclusion is that the conceptual and associative attributes dominate the immediate memory for words of older Ss. Although the tests for differences between the conceptual and associative attributes as a function of grade were not significant, it appeared from the error curves ir immediate retention (Figure 2) that the conceptual attribute became dominant over the associative attribute with increasing grade level. See Appendix B for a discussion of the term dominance in relation to memory attributes.

Another conclusion resulting from the experiment is that the memory attributes developed under intentional and incidental learning conditions do not appear to differ. This conclusion is not in agreement with previous studies (Wallace, 1968; Wallace & Calderone, 1969). However, it should be remembered that the hypothesis that incidental learners are deficient in implicit associative responses to the material being learned, was not unequivocally supported by previous research.

The findings related to the changes in memory attributes over the 48-hour retention interval were somewhat puzzling. There was a significant tendency for the proportions of associative and conceptual errors to increase and the proportion of acoustic errors to decrease over the 48-hour interval. However, a clear interpretation of this difference was prevented because of the behavior of the neutral error curve. While the acoustic error curve was above the neutral curve in immediate retention, the acoustic curve was clearly below the neutral curve after 48 hours. Since very little if any evidence was found for the use of a strategy by Ss which would allow them to avoid acoustic errors, the investigator offered the hypothesis that the neutral words were in fact not control words but instead represented idiosyncratic encoding categories. The acceptance of this hypothesis allows one to ignore the neutral curve as a baseline and focus on the changes in the other error curves as a function of grade and retention interval.

The interpretation of the changes in the error curves as a function of grade is that younger Ss, who are relatively deficient in implicit verbal responses to words, rely more heavily than older Ss on more primitive memory attributes which do not depend on such responses. The interpretation of the changes in error curves as a function of retention interval is that the acoustic attribute is forgotten more rapidly than the conceptual and associative attributes. This interpretation agrees with that of previous studies. (Anisfeld, 1969; Adams, Thorsheim & McIntyre, 1969; Bach & Underwood, 1970). The fact

that second-grade Ss showed greater forgetting over the 48-hour interval than the fourth- and sixth-grade Ss supports the interpretation of differential forgetting of attributes. If the dominant attribute for second-grade children is the acoustic attribute, then a loss of this attribute over time should be more deleterious for these Ss than for older Ss for whom other attributes are dominant.

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APPENDIX A

INSTRUCTIONS

INSTRUCTIONS

I am Miss Schwenn from the university and I am studying how Wisconsin boys and girls in your grade (second, fourth, sixth grade) pronounce certain words. I am interested in finding out how you pronounce these words because other boys and girls in different grades and in different parts of the United States may say the words in different ways. I want to find out if you say the words in a different way than children in Texas or California.

Listen carefully while I explain what we are going to do. I am going to show you words one at a time. The words will be printed on these cards. I will say the word first and then you will say the word as a group--together. This microphone will pick up your voices and what you say will be recorded on this tape recorder here.

When I show you each word, look at it carefully. Then wait for me to say it. After I say the word, all of you say it together. Try to say it as clearly as you can. Be sure to sit up straight and face the microphone so I can record each of your voices.

Intentional group: You must look and listen to each word carefully because I am also studying how well boys and girls in your grade can remember words. Try to remember all of the words because later I am going to give you some tests on the words. On the tests you will have to pick out the words I showed you from other words which I did not show you.

Remember I want each of you to say each word clearly and distinctly after I say i. O.K.? Are you ready?

Delayed group: Thats all the words I am going to show you today. You did very well. I will meet with you again on _____ and we will see some more words. Can all of you keep a secret? I want to see how well you can keep secret what we did today. If any of your friends ask what we did today, you just tell them you pronounced words but don't tell them any of the words. If you tell them the words then they will already know how to pronounce them when they come in and that wouldn't be fair. O.K.?

Recognition Tests

Immediate: That was very good. Now I am going to stop the tape recorder and give you a test to see how well you remember the words you just saw.

Delayed: Two days ago (on _____) I showed you some words to pronounce. Today I am going to test you to see if you remember the words I showed you.

All Ss: First I am going to give each of you a booklet, and I want you to print your name on the top line. The first test will be like this. I will show you a card with five words printed on it. One of those five words will be one of the words I showed you before (on _____) on the pronouncing task. The other words will be words I didn't show you. Your job is to pick out the word you saw before. There will be a number next to each word on the card. All you have to do to get a hundred on the test is pick out the number of the right word. When you have picked out the number of the right word, you draw a circle around that number in the box for test number 1 on your booklet. Does everyone see the box for test 1? Do you see the five numbers? Let's read the numbers together. Good. Now one of those numbers will be next to the correct word on the card I will show you. When you see the right word on the card you draw a circle around its number in the box. O.K.?

Before you draw your circle you must listen to me say the five words. You do not say the words this time. After I say all the words on the card I will say, "draw your circles," and you circle one of the numbers in box number 1.

If you are not sure about which word is the word you saw before try to guess it. But you must always circle one of the numbers. Before I give you the test I want to tell you that it is against the rules to help each other on the tests. Do not say the word or the number you choose out loud because that might give away the right answer and that would be cheating. You will not get a hundred on the test if you help your friends to get the answer. So each of you must keep your answers a secret from everybody else. Don't look at anybody else's paper and don't let anybody see your answers. Here is the first test. (Show card.)

The second test will be like the first one. I will show you another card with five words on it. I will say each of the words and then tell you to draw your circles. This time you will draw a circle around a number in the box for test 2. Draw a circle around the number which is next to the word which was one I showed you on the pronouncing task. Here is the card.

Now here is another test. Circle the number for the correct word in the box for test 3.

Final Instructions

Immediate group: Can all of you keep a secret? I want to see how well you can keep what we did today a secret. If any of your friends ask what we did just tell them we pronounced words but don't tell them about the tests. If you tell them about the words and the tests they will already know them when they come in and that would spoil the game. O.K.?

Delayed group: Did all of you keep our secret? Good. Well, I want you to still keep the secret since some of your friends will be coming in later. So don't tell them any of the words and don't tell them about the tests--just tell them we pronounced words like before O.K.?

Check on the Incidental Subjects

The following questions were asked of the incidental learners following their recognition test:

1. Did you think that you might be tested on the words which you pronounced?

2. Did you try to learn the words I had you pronounce?

3. (if answer to numbers 1 and 2 was yes) Did some of your friends tell you about the tests or did you guess it on your own?

APPENDIX B

SECOND TEST TRIAL

SECOND TEST TRIAL

After all 25 words had been tested for recognition, all Ss were given a second test on each word. On the second test trial the children were required to choose a different word than they chose on the first test. The CR words were deleted from the cards on the second test. Thus, if a S had chosen the CR on the first test, he had four alternatives from which to choose his second response. If the S made an error on the first test he had three words from which to choose. The following instructions concerning the second test were given to the children.

You have had a test for all of the words. Now I am going to test you on the words again. I am going to show you the same cards as I showed you on the first tests, and I want you to choose a different word than you chose the first time. Even if you think your first choice was right, I want you to choose another word which you think might also be right just in case you made a mistake the first time. This time you will use these red pencils to draw your circles.

Before I show you the first test card, I want you to take your left hand and put a finger over the number you circled in the box for test 1. This is so you cannot circle it again. Now choose one of these words. Oh yes, I forgot to put all the words on the card. Number ___ is missing so you cannot choose it. So put another finger over number ___. If you already have a finger over number ___ that's O.K. Now you can choose any word whose number is not covered by your fingers. From the words that are left, try to choose the word which seems to you to be the most correct. Choose the word which seems to you to be the one which you saw before on the pronouncing task.

Now here is the second test. Put your finger over the number you circled in the box for test number 2. Here are the words. On this test I left out word number ___ so if your finger is not already over number ___ put another finger over number ___. Now choose a word whose number is not covered. Choose a word which seems to be correct.

The purpose of the second test was to determine whether Ss encoded the words in a unitary fashion, that is, whether they used only one attribute, or whether Ss encoded words simultaneously on several attributes. The fact that one attribute may dominate another, for example, in the second grade the acoustic attribute dominated the associative and conceptual attributes, can be interpreted in two ways. First, it might mean that only one attribute becomes a part of the memory, the others not becoming a part. If this were true across all words for a given S, the correlations between the relative frequency of one type of error, in this example acoustic errors, and the relative frequency of the other errors should be high and negative. In fact, the correlations were negative but not large. However, this lack of correlation may simply mean that a given S may encode some words on one attribute only, and other words only on a different attribute. Thus, second-grade Ss may have simply encoded more of their words acoustically than did the fourth-and sixth-grade Ss. The second interpretation which may be given to the statement that one attribute dominates another is that all three attributes (and others not considered here) become a part of the memory but that Ss differ as a function of age in their preference for, or confidence in, one attribute over the others.

It was hoped that the technique of giving Ss a second choice would allow a decision between the two alternative ways of viewing possible differences in attribute dominance as a function of age. If more than one of the attributes becomes part of the memory for the word, then a forced choice between the remaining three alternatives

following an error should not result in equal frequencies for the three alternatives. Unfortunately the technique of the second test trial, at least under the procedure followed in the present experiment, did not yield data in which E had much confidence. The children in all grades appeared confused about what they were supposed to do. Perhaps it was a mistake to leave the CR off the second test; Ss appeared to be trying to recall the missing word (it became apparent to them after several tests that the missing word was the CR) and then basing their choice on the relationships of the remaining alternatives to the CR. Thus, the second test seemed to be measuring something quite different than traces of less dominant memory attributes.

APPENDIX C

ERROR SCORES

Grade 2

Immediate Retention

	Intentional				Incidental				
Boys	Ac	C	As	N		Ac	C	As	N
S #1	0	1	3	1	S #1	1	2	3	0
#2	3	7	8	2	#2	1	2	2	1
#3	3	6	3	2	#3	5	2	3	0
#4	3	1	3	5	#4	1	0	0	0
#5	4	3	0	4	#5	1	1	1	0
#6	4	2	1	2	#6	0	0	0	0
#7	2	1	4	3	#7	1	1	2	2
#8	0	0	4	1	#8	2	4	3	1
#9	3	1	1	1	#9	1	0	4	0
#10	2	2	2	4	#10	0	0	0	0
Girls									
S #1	2	0	1	0	#1	3	0	0	0
#2	2	1	0	0	#2	0	0	0	1
#3	2	3	0	2	#3	2	2	1	1
#4	1	0	0	0	#4	0	1	0	1
#5	5	3	1	1	#5	2	0	1	2
#6	1	3	1	1	#6	1	1	0	0
#7	3	2	2	0	#7	1	0	2	0
#8	0	1	2	2	#8	1	0	4	3
#9	1	2	1	2	#9	0	0	3	0
#10	0	2	0	1	#10	3	4	2	0

Grade 2

Delayed Retention

	Intentional					Incidental				
Boys	Ac	C	As	N		Ac	C	As	N
S #1	1	3	1	8	S #1	0	8	4	4
#2	0	7	4	5	#2	3	2	1	2
#3	2	6	8	5	#3	3	5	4	5
#4	1	6	2	10	#4	1	3	6	3
#5	2	3	8	3	#5	3	4	6	7
#6	3	3	7	6	#6	3	3	6	5
#7	2	8	3	5	#7	4	6	6	4
#8	0	1	2	5	#8	3	5	4	2
#9	0	4	8	7	#9	4	4	5	2
#10	4	3	4	3	#10	3	5	8	3
Girls									
S #1	3	3	5	6	S #1	2	3	4	5
#2	1	9	6	3	#2	0	5	6	4
#3	1	4	5	7	#3	1	3	5	5
#4	2	3	5	2	#4	1	7	4	3
#5	2	2	0	3	#5	2	2	6	2
#6	1	3	7	3	#6	1	2	3	4
#7	4	3	8	4	#7	3	6	6	1
#8	2	6	5	1	#8	3	5	8	4
#9	1	4	4	6	#9	2	3	8	7
#10	3	5	2	4	#10	5	2	4	6

Grade 4

Immediate Retention

		Intentional					Incidental			
Boys		Ac	C	As	N		Ac	C	As	N
S	#1	1	0	0	2	#1	2	2	4	2
	#2	1	0	3	0	#2	1	2	0	1
	#3	3	5	2	0	#3	2	2	3	2
	#4	0	0	0	0	#4	1	1	1	1
	#5	0	5	1	0	#5	2	2	3	1
	#6	2	4	5	3	#6	3	2	4	4
	#7	2	1	0	0	#7	3	5	3	3
	#8	0	8	6	2	#8	0	1	2	0
	#9	4	1	2	4	#9	3	0	1	0
	#10	4	3	1	0	#10	1	2	1	2
Girls										
S	#1	1	5	3	3	#1	2	1	0	0
	#2	0	2	3	1	#2	3	1	5	3
	#3	2	2	0	2	#3	0	0	1	2
	#4	2	1	0	0	#4	1	7	5	2
	#5	2	2	5	5	#5	3	5	1	1
	#6	3	3	1	0	#6	1	1	0	1
	#7	2	0	4	2	#7	2	0	2	1
	#8	0	1	5	3	#8	1	4	2	1
	#9	1	2	2	3	#9	2	3	3	1
	#10	1	3	4	4	#10	0	0	1	0

Grade 4

Delayed Retention

		Intentional					Incidental			
Boys		Ac	C	As	N		Ac	C	As	N
S	#1	3	8	2	4	S #1	0	7	6	1
	#2	3	10	2	2	#2	2	2	2	3
	#3	2	0	4	5	#3	2	7	4	3
	#4	2	7	5	4	#4	4	4	2	3
	#5	1	13	5	4	#5	3	8	3	2
	#6	1	7	2	5	#6	2	3	5	3
	#7	2	5	4	3	#7	1	3	2	3
	#8	2	2	5	3	#8	1	8	6	1
	#9	2	8	5	4	#9	0	7	2	4
	#10	1	7	5	6	#10	2	5	4	4
Girls										
S	#1	3	3	4	4	#1	0	4	4	3
	#2	2	10	2	1	#2	1	4	3	7
	#3	2	6	2	7	#3	2	3	5	3
	#4	5	4	4	4	#4	4	5	1	6
	#5	2	2	1	6	#5	2	1	3	4
	#6	4	2	2	8	#6	3	4	3	7
	#7	1	8	2	2	#7	1	9	2	5
	#8	4	2	4	1	#8	2	7	3	1
	#9	2	4	2	7	#9	0	3	6	4
	#10	4	8	5	4	#10	2	2	7	4

Grade 6

Immediate Retention

		Intentional					Incidental			
Boys		Ac	C	As	N		Ac	C	As	N
S	#1	3	3	7	1	S #1	4	2	0	4
	#2	1	0	1	1	#2	2	5	1	4
	#3	0	2	4	3	#3	4	1	1	2
	#4	4	4	6	3	#4	2	3	2	0
	#5	1	7	3	3	#5	2	4	4	1
	#6	3	0	5	2	#6	1	1	5	0
	#7	3	4	5	2	#7	2	6	1	6
	#8	0	3	1	0	#8	0	2	2	0
	#9	1	3	0	0	#9	0	1	0	2
	#10	0	1	0	0	#10	0	2	3	1
Girls										
S	#1	0	1	0	0	#1	2	0	0	1
	#2	1	0	4	0	#2	0	1	1	0
	#3	5	1	0	0	#3	1	4	0	1
	#4	0	1	2	3	#4	0	5	3	0
	#5	0	3	2	0	#5	2	2	6	6
	#6	0	0	0	0	#6	1	5	3	2
	#7	2	1	0	2	#7	0	3	0	1
	#8	0	0	1	1	#8	1	3	3	3
	#9	1	2	2	2	#9	1	0	0	0
	#10	0	0	0	0	#10	1	2	3	1

Grade 6

Delayed Retention

		Intentional					Incidental			
Boys		Ac	C	As	N		Ac	C	As	N
S	#1	2	0	6	8	S #1	0	3	3	3
	#2	2	3	7	8	#2	1	4	5	3
	#3	2	5	5	2	#3	4	8	1	3
	#4	3	6	2	5	#4	0	2	5	0
	#5	0	3	7	4	#5	1	5	8	3
	#6	2	5	3	3	#6	4	7	5	2
	#7	1	4	1	3	#7	1	7	3	2
	#8	1	3	3	5	#8	1	3	4	7
	#9	3	3	10	2	#9	1	6	3	3
	#10	2	5	2	4	#10	2	5	8	2
Girls										
S	#1	0	4	7	5	#1	3	6	2	3
	#2	0	5	5	4	#2	2	6	6	3
	#3	2	3	2	4	#3	1	5	4	7
	#4	3	3	4	3	#4	0	3	1	4
	#5	3	4	1	6	#5	4	4	7	1
	#6	2	7	3	1	#6	2	0	3	5
	#7	0	2	2	1	#7	0	3	3	3
	#8	1	5	1	8	#8	0	6	5	3
	#9	3	3	2	3	#9	2	5	5	4
	#10	4	7	2	1	#10	3	3	4	7